PB82-257130

Draft Environmental Impact Statement Wastewater Treatment Facilities, City of Norman, Cleveland County, Oklahoma

(U.S.) Environmental Protection Agency
Dallas, TX

Jul 82

United States
Environment
Agency

Region 6
1201 Elm Street
Dallas, TX 75270

EPA 906/9-82-008
July, 1982

PB82-257130

Water

EPA

Environmental Impact Statement

Draft

Wastewater Treatment Facilities

City of Norman
Cleveland County, Oklahoma

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U.S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO. EPA 906/9-82-008	2.	3. RECIPIENT'S ACCESSION NO. PB82 257130
4. TITLE AND SUBTITLE Draft Environmental Impact Statement, Wastewater Treatment Facilities, Norman, Cleveland County, Oklahoma		5. REPORT DATE July 1982
		6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) Numerous		8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS U. S. Environmental Protection Agency, Region 6 1201 Elm Street Dallas, Texas 75270		10. PROGRAM ELEMENT NO. A7VB2G
		11. CONTRACT/GRANT NO. Grant No. C-400899-01-0
12. SPONSORING AGENCY NAME AND ADDRESS U. S. Environmental Protection Agency, Region 6 1201 Elm Street Dallas, Texas 75270		13. TYPE OF REPORT AND PERIOD COVERED
		14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES

COLOR ILLUSTRATIONS REPRODUCED IN BLACK AND WHITE

16. ABSTRACT

The city of Norman operates sewage treatment works that serve the city and the University of Oklahoma. Major problems include: 1) a treatment facility that is inefficient and cannot meet state and Federal standards for effluent quality; 2) an existing collection system that cannot accommodate existing flows; and 3) inadequate collection and treatment capacity for future growth. Alternatives to accommodate expected flows to the year 2000 were analyzed. Based on environmental analysis and public participation, the following appears to be the most cost-effective alternative: new interceptors, lift stations and collection lines; upgrading of the present treatment plant using bio-discs to provide secondary treatment; and sludge facilities for anaerobic digestion followed by wet-injection disposal. Principal impacts of this alternative would be: facilitation of the conversion of about 600 acres of environmentally significant agricultural lands to urban land uses; support of orderly, environmentally sound growth in compliance with the city's land use plan (COMPLAN); approximately a 3 percent increase in pollutant loadings to Lake Thunderbird; improved water quality in the South Canadian River; reduction of odors and elimination of overflows within the collection system; and lifting of the hookup moratorium in the Bishop Creek area.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group

18. DISTRIBUTION STATEMENT Release to Public	19. SECURITY CLASS *(This Report)* Unclassified	21. NO. OF PAGES
	20. SECURITY CLASS *(This page)* Unclassified	22. PRICE

EPA Form 2220-1 (Rev. 4-77) PREVIOUS EDITION IS OBSOLETE

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION VI
1201 ELM STREET
DALLAS, TEXAS 75270

July 14, 1982

TO ALL INTERESTED AGENCIES, OFFICIALS, PUBLIC GROUPS AND INDIVIDUALS:

Attached is a copy of the Draft Environmental Impact Statement (EIS) on the awarding of a construction grant under Section 201 of the Clean Water Act for upgrading and expansion of wastewater treatment facilities in Norman, Cleveland County, Oklahoma. The EIS has been prepared concurrently with a wastewater treatment facilities plan under a grant from the U.S. Environmental Protection Agency.

This document has been prepared in compliance with the National Environmental Policy Act of 1969 and implementing regulations. Written comments or inquiries regarding this EIS should be addressed to Mr. Clinton B. Spotts, Regional EIS Coordinator, at the above address, by the date stamped on the cover sheet following this letter.

EPA and the city of Norman will hold a public hearing on the Draft EIS and the draft facilities plan at 7:30 p.m., Thursday, September 2, 1982, in the Multi-Purpose Room of the Pioneer Multi-County Library at 225 North Webster in Norman, Oklahoma. Comments made at the public hearing and written comments received by EPA will be considered in the preparation of the Final EIS.

If changes required in the Draft EIS are minor, the Final EIS will incorporate the Draft EIS by reference and include only: (1) a revised summary; (2) revisions necessary to the Draft EIS as a result of public comment; and (3) EPA's response to comments made on the Draft EIS. Therefore, the Draft EIS should be retained for possible use in conjunction with the Final EIS. The Final EIS will be sent only to those who request a copy or who make substantive comments on the Draft EIS.

The Draft EIS is being distributed to Federal and State agencies and other interested parties. The Draft EIS, supporting information and the draft facilities plan may be reviewed at the following locations:

Norman City Clerk's Office
201 West Gray
Norman, Oklahoma

Pioneer Multi-County Library
225 North Webster
Norman, Oklahoma

Oklahoma State Dept. of Health
Water Facilities Engineering Service
Construction Grants Division
1000 NE 10th Street
Oklahoma City, Oklahoma

U.S. Environmental Protection Agency
First International Bldg., 28th Floor
1201 Elm Street
Dallas, Texas

If you need additional information, please contact Clinton B. Spotts at (214) 767-2716 or (FTS) 729-2716.

Sincerely yours,

Frances E. Phillips

Dick Whittington, P.E.
Regional Administrator

DRAFT ENVIRONMENTAL IMPACT STATEMENT

WASTEWATER TREATMENT FACILITIES
NORMAN, OKLAHOMA

RESPONSIBLE AGENCY: United States Environmental Protection Agency, Region 6

ACTION BEING CONSIDERED: Possible awarding of construction funds for wastewater treatment facilities for the city of Norman, Oklahoma.

CONTACT FOR FURTHER INFORMATION:

Clinton B. Spotts, Regional EIS Coordinator
U.S. Environmental Protection Agency, Region 6
1201 Elm Street
Dallas, Texas 75270
Phone: Commercial (214) 767-2716
FTS 729-2716

ABSTRACT: The city of Norman operates sewage treatment works that serve the city and the University of Oklahoma. Major problems include: (a) a treatment facility that is inefficient and cannot meet state and federal standards regarding effluent quality; (b) an existing collection system that cannot accommodate existing flows, and (c) inadequate collection and treatment capacity to accomodate the substantial growth projected to occur in the planning area. Alternatives regarding service area, collection system improvements, wastewater treatment, and sludge management were analyzed to accommodate expected flows to the year 2000. The city of Norman has not yet selected its preferred alternative. Based on environmental analysis and public participation, the following appears to be the most cost-effective alternative: new interceptors, lift stations, and collection lines; upgrading of the present treatment plant using bio-discs to provide secondary treatment; and sludge facilities for anaerobic digestion followed by wet-injection disposal. Principal impacts of this alternative would be: facilitation of the conversion of about 600 acres of environmentally significant agricultural lands to urban land uses; support of orderly, environmentally sound growth in compliance with the city's land use plan (COMPLAN); approximately a 3 percent increase in pollutant loadings to Lake Thunderbird, the city's main drinking water supply; improved water quality in the South Canadian River; reduction of odors and elimination of overflows within the collection system; and lifting of the hookup moratorium in the Bishop Creek area.

COMMENTS ON DRAFT EIS DUE: SEP 13 1982

RESPONSIBLE OFFICIAL:

Frances E. Phillips

Dick Whittington, P.E.
Regional Administrator

CHAPTER I

SUMMARY

1. SUMMARY

1.1 EXISTING PROBLEMS

The city of Norman owns and operates wastewater collection facilities which include lines and lift stations which are now severely overloaded (for example, the Bishop Creek interceptor system and a portion of the Normandy Creek interceptor), or which will be overloaded by the year 2000 (for example, along Imhoff Creek and at Woodcrest lift station). Sewage overflows expose area residents and visitors to potential health hazards; odors infringe on enjoyment of outdoor activities. A hookup moratorium is in effect in the Bishop Creek area, whereas urbanization of the area is desirable according to the policies of the recently adopted comprehensive plan (COMPLAN). The most serious problems of the Bishop Creek system are being addressed through advance construction of key interceptor sewers.

The treatment plant, which discharges to the South Canadian River, is now overloaded with respect to organic matter, due especially to poor performance by the secondary filter system and aerated lagoon-final clarifier system. Because of these problems, the effluent does not meet standards set by the city's NPDES permit. Projected population growth will add to the potential that effluent discharges will exceed standards. Alternatives for improving effluent quality must be flexible, as definite effluent standards for Norman have not been determined because of uncertainties about future beneficial-use requirements and water-quality criteria.

Sludge digesters are presently operating near their full capacity. Current sludge disposal practices do not conform with EPA regulations because primary sludge is disposed of in a flood plain and on sites not completely controlled by the city. Secondary sludge is not fully disinfected prior to sale to the public.

A major public concern in developing solutions to these problems is that urbanization associated with sewer extensions may cause severe problems of nonpoint-source pollution, especially related to runoff into Lake Thunderbird, the major water-supply reservoir of the region. In 1977, EPA withdrew federal funds for construction of two lift stations proposed for the watershed above Lake Thunderbird, on the basis of potential adverse water-quality impacts on the reservoir.

1.2 PROJECT ALTERNATIVES CONSIDERED BY THE APPLICANT

No Action. The alternative of taking no action has been rejected by the city because failure to address the problems cited in section 1.1 would cause: continued violation of federal effluent regulations and impairment of the South Canadian River as a habitat and recreational resource; potential health and odor problems throughout the city; overloading of sludge facilities and associated odor and vector problems. The probable expansion of the hookup moratorium area would increase the pressure for growth in rural areas, where septic tanks can be utilized on relatively large lots. Extensive development beyond the relatively compact urban core would be counter to the adopted comprehensive plan because of its greater cost and environmental impact.

Service area. Norman proposes to extend the service area of the municipal sewer system according to population projections which were prepared in conformance to the COMPLAN; the plan is aimed at accommodating projected growth, providing services in a cost-effective manner, preserving agricultural lands, protecting the Lake Thunderbird drainage, and generally minimizing the adverse environmental impacts of growth. The specific proposals principally involve new service to a small portion of the Little River basin which is on the fringe of the currently urbanized area.

The proposed expansion of the service area into previously unsewered basins would facilitate future development of approximately 1,500 acres of prime agricultural lands and 3100 acres of additional land of local and state-wide agricultural service importance. These lands account for about 1.5 percent of the county's important farmlands, as defined by the U.S. Soil Conservation Service. However, most development would occur after the year 2000; a total of about 600 acres would be absorbed by the end of the planning period, or 0.2 percent of the important farmlands. The sewers which would serve the expanded service area are sized to accommodate only the growth projected through the year 2000. For the remaining land in these basins to develop, additional interceptors would have to be provided which would require review and approval prior to construction. The proposed facilities would, therefore, affect no more than 600 acres of farmland in the expanded service area. Most of the agricultural land which would be impacted is pasture or rangeland. Negative impacts of the proposed service area expansion on agricultural land would be minor because: large acreages of important farmlands would remain; there would be no impact on Norman's most productive agricultural lands, which are located in the western-most part of town; remaining agricultural areas would be protected by encouraging urbanization to occur in a compact, orderly form; additional high-density growth could not occur without review and approval for the construction of new interceptors.

Nearly 4700 acres of the Little River basin that are currently undeveloped would be opened to potential development at urban densities (8 people/acre or more). This development would increase the potential that urban runoff would contaminate Lake Thunderbird. But, as for agricultural lands, the actual impact of the proposed expansion would be much less. About 600 presently vacant acres would be expected to be developed by the year 2000. For most pollutants, the projection is that by the year 2000 the concentrations of pollutants in runoff from the affected acres would increase by approximately 85 to 285 percent, depending on the pollutant. However, because the total acreage is small, the net impact on Lake Thunderbird would be small. The magnitude of change in the water quality of Lake Thunderbird is illustrated by phosphorus loadings to the lake, which would increase by approximately three percent above present loadings.

From all sources in the watershed, phosphorus loadings could increase by 50 percent by the year 2000. Most of this change reflects growth outside the Norman city limits, especially in the city of Moore. Additional development past the year 2000 would further increase the potential for pollutants to reach the reservoir. These estimates do not account for the potential mitigating effects of ponds within the watersheds, or the benefits from implementation of the city's new drainage ordinance.

It is not certain that the increased phosphorus loading would result in any major change in the chemistry or biology of the reservoir. The high sediment load in the lake could fully compensate for the increased pollutant loading by: a) adsorbing many of the contaminants; and b) reducing the availability of light which is a prerequisite to nuisance algal blooms. Still, there is some risk that phosphorus concentrations would cross a significant threshold, and lead to major and even irreversible changes in the reservoir. The conclusion, then, is that there is a potential for adverse impacts on Lake Thunderbird from land conversion, but that harm is not certain. The growth facilitated by the expanded service area accounts for only a portion of the impact; in combination with other projected growth it could be a cause for concern.

Alternatives to the proposed service area could have more significant adverse impacts on the community as a whole. For example, the most realistic alternative would be to attempt to shift the growth to the west of town in the South Canadian basin. However, this area contains Norman's most productive farms which would be lost as land was converted for urban use. Further, this would not preclude development in the sensitive Little River basin, because growth in Moore, rural Norman, and elsewhere would continue to impact the reservoir.

Collection system. The location and sizing of all facilities is determined by the population projections associated with the COMPLAN, and by the requirement that all sewage collected in the Little River basin must be pumped into the Canadian basin, since discharge of wastewater within the Little River basin is prohibited by regulation of the Central Oklahoma Master Conservancy District.

Specific interceptor routing alternatives included the following. 1) Parallel existing interceptors with new ones; this approach, which uses existing rights-of-way, was selected when feasible unless construction impacts were severe. 2) Rework the system to divert excess flows into an interceptor which has adequate capacity; this potentially inexpensive approach was selected in those few cases where an overloaded line is close to one with excess capacity. 3) Build new interceptors from developed and developing areas to the treatment plant; this was generally chosen when it allowed selection of a right-of-way along a flood plain or outside already developed areas, in order to minimize construction costs and impacts.

The Applicant proposes to construct approximately 14.7 miles of new sewer lines by the year 2000 under the construction grant; eligibility of these lines has not been determined by EPA. In addition, over 23 miles of sewer line not eligible for funding must be installed to correct current problems. Construction impacts, such as erosion, noise, traffic disruption and disturbance of archaeological sites will be mitigated by measures which will be defined during the design and construction phases of each construction project, when alignments are defined precisely. One line passes near a wildlife preserve; special measures may be needed to avoid impacts to this area. Portions of four interceptors would be located in flood plains. These lines, along Imhoff Creek, Bishop Creek, Normandy (Merckle) Creek, and an unnamed tributary of the Little River, would have special impacts associated with flood and erosion hazards. In some places dewatering may be necessary due to a shallow water table. One proposed lift station is located such that development could occur in a manner inconsistent with the plan; an alternative site exists which would avoid this impact.

Wastewater treatment and disposal. Seven major engineering concepts were considered for expanding or replacing the existing plant. Four of the seven alternatives are designed to accomplish secondary treatment, the minimum which will be required of the Norman plant; the remaining three are intended to provide very advanced treatment, including nutrient removal, which is the most restrictive requirement now being considered.

Table 1-1 summarizes the evaluation of the alternatives; the table includes the total dollar cost of each treatment process and a comparative ranking of the alternatives with respect to a number of economic, engineering and environmental issues. On the basis of the rankings, the facilities plan considers that alternative 4 (bio-discs) is the preferred method for accomplishing secondary treatment and that alternative 5 (biological nitrification) is the best means of further upgrading the facility for advanced treatment, if required. The selected options feature low dollar costs and good engineering characteristics related to operations, reliability and adaptability; environmental impacts are similar to or less severe than for other alternatives.

Wastewater reuse. Arrangements are in progress to possibly utilize a portion of the treated wastewater for golf course irrigation at the University of Oklahoma. The land application alternative presented in table 1-1 would provide a combination of wastewater treatment and reuse. This alternative would reduce the discharge to the river, which would reduce the potential of the river to provide beneficial uses that relate to quantity. On the other hand, quality impacts of wastewater discharge would be eliminated if land application is implemented. Reasons for rejecting land application include: the large land requirement (3,930 acres) which required consideration of a relatively distant site; displacement of residences at the site; the high dollar costs of land, storage ponds and a pipeline; potential odors at storage ponds.

Sludge management. Four specific alternatives for sludge management were considered in detail. Table 1-2 summarizes the evaluation of the alternatives; the table includes the total dollar cost of each management

TABLE 1-1. RANKING OF WASTEWATER TREATMENT ALTERNATIVES.

1 is 'best'; 3 is 'least desirable'.

	Level A (Secondary)				Level D (Advanced)		
	Alt. 1 Jet Activated Sludge	Alt. 2 Biofilter/ Jet Activated Sludge	Alt. 3 Biofilter/ Conventional Act. Sludge	Alt. 4 Biofilters/ Bio-discs	Alt. 5 Biological Nitrification	Alt. 6 Breakpoint Chlorination	Alt. 7 Land Application
Present Worth of All Costs	$ 13,451,523	13,650,275	12,262,105	11,561,778	29,121,323	32,688,093	47,197,276
Evaluation Parameters:							
Dollar Costs	3	3	2	1	1	2	3
Operation and Maintenance	3	3	2	1	2	3	1
Reliability	2	1	1	2	2	1	2
Adaptability	3	1	2	1	1	1	3
Environmental Considerations	2	2	2	2	1	1	3
Public Acceptability	3	3	2	1	1	2	3
TOTAL	16	13	11	8	8	10	15

Sources: PSC, 1981.

TABLE 1-2. SUMMARY OF EVALUATION OF SLUDGE MANAGEMENT ALTERNATIVES.

Ranking of 1 is 'best'; 4 is 'least desirable'. See table 5-7 for greater detail.

	Alternative 1 Lime Conditioning Land Application	Alternative 2 Anaerobic Digestion Land Application	Alternative 3a Codisposal Cogeneration	Alternative 3b Codisposal ELectricity Only	Alternative 4 Incineration No Energy Recovery
Total Present Worth					
Level A	$ 4,073,380	$ 4,439,783	$ 2,196,978[a]	$ 5,226,027[a]	$ 10,676,304
Level D	$ 6,711,728	$ 7,078,131	$ 3,831,953[a]	$ 7,294,789[a]	$ 12,764,264
Evaluation Parameters:					
Dollar Costs	2	2	1	3	4
Energy Use	1	1.5	3	3	4
Chemical Use	4	1	2.5	2.5	2.5
Land Use	4	3.5	1.5	1.5	1
Energy Production	3	2	1	1	4
Fertilizer Value	1	2	4	4	4
Cost Recovery Potential	2	3	1	1	4
Ease of Implementation	2	1	4	4	3
Ease and Flexibility of Operation	2	1	4	4	3
Process Control (Reliability)	2	3	4	4	1
Safety of Operation	2	1	4	4	3
Odor Potential	3	4	1	1	1
Bacterial/Viral Safety	3	4	1	1	1
Air Quality Impacts	1	1	4	4	3
Ground Water Quality Impacts	3	4	2	2	1
Public Acceptance	2	1	3	3	4
Total	37	35	41	42.5	43.5

---

a. Sludge portion only. Total cost for coincineration of sludge and refuse would be greater. See table 5-6.

method and a comparative ranking of the alternatives with respect to a number of economic, engineering and environmental issues. On the basis of the rankings, alternative 2 appears to be the most cost-effective method. (It is somewhat more expensive than alternative 1, but uses less sophisticated technology and is easier to implement or modify.) This is a different conclusion from the facilities plan, which recommends alternative 3a.

The principal differences between alternatives 2 and 3 are: a) alternative 3 is energy intensive, whereas alternative 2 requires large amounts of land; b) the economic analysis of alternative 3a assumes revenues from electricity and steam production; however a stream customer has not been identified; c) the economics of alternative 3 do not consider the costs for coincineration of refuse with the sludge, which may be substantially greater than landfill disposal of refuse; d) alternative 2 would utilize the organic value of sludge, and could potentially provide energy due to methane production; e) alternative 2 would use relatively simple technology, would be easy to implement, and is quite flexible in operation, whereas alternative 3 would require very sophisticated and relatively inflexible equipment; f) alternative 3 has potential air quality impacts; g) alternative 2 could produce odors on the fringe of the urban area; alternative 2 would provide the least disinfection and greatest potential for groundwater pollution.

The public participation process has identified alternative 2 as the preferred choice because it is easy to implement, and could easily be modified if a different sludge management system became desirable in the future. Although alternative 3a shows the lowest total present worth, it was not preferred by the Citizen's Advisory Committee because: there would be additional costs for the refuse portion of coincineration; the high technology involved is unacceptable to many citizens; and, the low cost of alternative 3a assumes sale of steam, but no steam customer has been identified.

Other alternatives. Continuation of existing practices is proposed with respect to: management of on-site systems and septage; disinfection by chlorination. Energy conservation was a major factor leading to the facilities plan selection of bio-discs. Energy conservation measures related to detailed design of the treatment system will be considered during facility design. Odor at the treatment plant will be reduced by construction of a screw pump lift station.

Federal funding will be sought for the eligible portion of the proposed construction. Monthly residential sewer use fees would be about $15.00 per month at one hundred percent local financing, compared to about $4.00 per month at present. Alternative means of financing now being considered include: sales tax; increased connection fees; the use of stand-by charges; and the establishment of specific policies towards financing of interceptor extensions.

Applicant's preferred alternative. The city of Norman has not yet selected their preferred alternative. Based on the environmental analysis presented in this document, and on public participation, the following appears to be the most cost-effective alternative for construction of wastewater facilities: new interceptors, lift stations, and collection lines; a bio-disc facility for secondary treatment; and sludge facilities for anaerobic digestion followed by wet application. The facilities would be capable of treating 10 mgd of effluent in compliance with NPDES permit requirements. Effluent would be discharged to the South Canadian as at present. Proposed interceptors would provide capacity for 20 years of development to the north and/or east; no additional capacity is proposed for areas south or west of Norman. This alternative is considered by the Applicant to be: 1) the most adaptable in the face of changing federal regulations for effluent and sludge disposal; 2) the most flexible in terms of construction and operation, especially for near-term solution of NPDES compliance problems; and 3) the least expensive in total resource use. Therefore, these options appear to be the most cost-effective alternatives available to the city. Table 1-3 summarizes the impacts of this proposal.

1.3 EPA ALTERNATIVES

The United States Environmental Protection Agency (EPA) may choose to fund all, part, or none of the alternative ultimately selected by the Applicant, or some other alternative. Any decison to limit or deny funding would not remove the Applicant's responsibility to comply with NPDES permit requirements.

TABLE 1-3. SUMMARY OF IMPACTS OF THE APPLICANT'S PROBABLE PREFERRED ALTERNATIVE.*

Adverse impacts are generally those which cannot be avoided except by the No Action Alternative; most of the adverse impacts can be mitigated. In addition to impacts identified below. substantial short-term benefits are associated with construction jobs, expenditures.

*A preferred alternative has not been selected; this table is based on the most likely alternative: treatment - Alt. 4 biofilter/biodiscs; sludge management - Alt. 2 anaerobic digestion, land application; proposed collection system.

ENVIRONMENTAL RESOURCE	SHORT-TERM ADVERSE IMPACTS	LONG-TERM ADVERSE IMPACTS	LONG-TERM BENEFITS
EARTH RESOURCES	Accelerated water erosion resulting from construction of facilities, especially where sewer lines lie in or cross a waterway	Sludge injection site could experience increased erosion, metals buildup in soils	Improved soil properties at sludge injection site (possibly enabling ultimate recycling of soil)
WATER RESOURCES	Dewatering during construction could cause water-table lowering, odors, water-quality changes	New interceptors located in flood hazard zones; degraded water quality in ruoff; potential degradation of water quality of Lake Thunderbird and of ground water beneath sludge disposal site	Increased flows in Canadian due to greater wastewater discharge. Improved quality of the Canadian, due to enhanced quality of effluent
AIR QUALITY; ODOR; NOISE	Equipment exhausts, dust and noise during construction	Small increase in emissions, noise at treatment plant; potential odors from sludge land application site	Reduced odors at treatment plant and from collection system
BIOLOGY	Temporary loss of vegetation and habitat at some construction sites, especially waterways	Loss of grasslands habitats at disposal sites; possible removal of some trees along creek alignments; potential decrease of fish in Lake Thunderbird and wildlife which feed on fish	Improved aquatic habitat in the Canadian; productivity and habitat value of sludge injection site ultimately improved
ARCHAEOLOGICAL & HISTORICAL RESOURCES	None expected	Possible loss of archaeological resources at new facilities, although no impacts are likely	No impact
SOCIO-ECONOMICS AND LAND USE	Traffic and utility disruption along construction corridors; reduced access to businesses and homes	Loss of agricultural land to support growth; potential impact on water quality of Lake Thunderbird with attendant impact on its value as a water supply and recreational resource; substantial increases in sewer rates or property taxes	Collection system supports compact urban form which will minimize impacts on agricultural land while supporting planned infrastructure; elimination of potential health hazards from overflows; potential use of some interceptor alignments for trails; restoration of land values and construction activity in Bishop Creek area
ENERGY & OTHER RESOURCES	Utilization of energy and resources during construction	Wastewater treatment requires major commitments of funds, labor, energy, materials	Net reduction in per capita resource use for wastewater treatment; support of compact urban form which requires less energy use

CHAPTER 2

TABLE OF CONTENTS

2. TABLE OF CONTENTS

Page

COVER SHEET

1. SUMMARY 1- 1

1.1 EXISTING PROBLEMS 1- 1
1.2 PROJECT ALTERNATIVES CONSIDERED BY APPLICANT 1- 1
1.3 EPA ALTERNATIVES 1- 8

2. TABLE OF CONTENTS 2- 1

3. INTRODUCTION 3- 1

3.1 BACKGROUND ON APPLICANT AND APPLICATION 3- 1
3.2 EPA LEGISLATIVE AUTHORITY AND RESPONSIBILITIES 3- 4
3.3 INVOLVEMENT OF OTHER AGENCIES 3- 6

4. PURPOSE AND NEED 4- 1

4.1 PROBLEMS WHICH NEED TO BE ADDRESSED 4- 1
4.2 ADVANCE CONSTRUCTION OF BISHOP CREEK INTERCEPTOR 4- 5
4.3 TREATMENT REQUIREMENTS; WASTELOAD ALLOCATIONS 4- 7
4.4 PURPOSE OF EIS 4-12

5. DESCRIPTION AND EVALUATION OF ALTERNATIVES 5- 1

PART A. ALTERNATIVES CONSIDERED BY APPLICANT 5- 1

5.1 NO ACTION ALTERNATIVE 5- 1

5.2 COLLECTION SYSTEM ALTERNATIVES 5- 3
5.2.1 Service Area 5- 3
5.2.2 Sewerage System Alternatives 5- 9
5.2.3 Summary of Construction Impacts 5-22

5.3 ALTERNATIVES FOR WASTEWATER TREATMENT AND DISPOSAL/REUSE 5-24
5.3.1 Treatment Process Alternatives 5-24
5.3.2 Alternatives for Wastewater Reuse 5-31
5.3.3 Alternatives for Plant Location 5-32

5.4 ALTERNATIVES FOR SLUDGE MANAGEMENT 5-32

5.5 OTHER ALTERNATIVES 5-43
5.5.1 On-Site Systems; Septage Disposal 5-43
5.5.2 Disinfection 5-44

Page

5.5.3 Energy Conservation 5-45
5.5.4 Odor Reduction 5-45
5.5.5 Water Conservation 5-46
5.5.6 Other Pollutant Sources 5-46
5.5.7 Administrative Alternatives 5-48
5.5.8 Project Funding 5-48

5.6 APPLICANT'S PREFERRED ALTERNATIVE 5-49

PART B. ALTERNATIVES AVAILABLE TO EPA 5-51

6. ENVIRONMENTAL CONSEQUENCES OF ALTERNATIVES 6- 1

6.1 EARTH RESOURCES 6- 2
6.1.1 Existing Conditions 6- 2
6.1.2 Impacts of the No Action Alternative 6- 6
6.1.3 Impacts of Collection Alternatives 6- 7
6.1.4 Impacts of Treatment Alternatives 6- 7
6.1.5 Impacts of Sludge Management Alternatives 6- 7
6.1.6 Impacts of Other Alternatives 6- 8
6.1.7 Impacts of EPA Alternatives 6- 8

6.2 WATER RESOURCES 6- 8
6.2.1 Existing Conditions: Surface Water Quantity 6- 9
6.2.2 Existing Conditions: Ground Water Quantity 6-15
6.2.3 Existing Conditions: Water Quality 6-15
6.2.4 Existing Conditions: Water Supply 6-29
6.2.5 Impacts of the No Action Alternative 6-29
6.2.6 Impacts of Collection Alternatives 6-29
6.2.7 Impacts of Treatment Alternatives 6-35
6.2.8 Impacts of Sludge Management Alternatives 6-37
6.2.9 Impacts of Other Alternatives 6-38
6.2.10 Impacts of EPA Alternatives 6-38

6.3 AIR QUALITY; ODOR; NOISE 6-39
6.3.1 Existing Conditions 6-39
6.3.2 Impacts of the No Action Alternative 6-43
6.3.3 Impacts of Collection Alternatives 6-43
6.3.4 Impacts of Treatment Alternatives 6-44
6.3.5 Impacts of Sludge Management Alternatives 6-45
6.3.6 Impacts of Other Alternatives 6-47
6.3.7 Impacts of EPA Alternatives 6-47

6.4 BIOLOGY 6-47
6.4.1 Existing Conditions: Biology 6-47
6.4.2 Existing Environment: Endangered Species 6-50
6.4.3 Impacts of the No Action Alternative 6-51
6.4.4 Impacts of Collection Alternatives 6-51

Page

6.4.5 Impacts of Treatment Alternatives 6-52
6.4.6 Impacts of Sludge Management Alternatives 6-53
6.4.7 Impacts of Other Alternatives 6-54
6.4.8 Impacts of EPA Alternatives 6-54

6.5 ARCHAEOLOGICAL AND HISTORICAL RESOURCES 6-54
6.5.1 Existing Conditions 6-54
6.5.2 Impacts of the No Action Alternative 6-55
6.5.3 Impacts of Collection Alternatives 6-55
6.5.4 Impacts of Treatment Alternatives 6-55
6.5.5 Impacts of Sludge Management Alternatives 6-56
6.5.6 Impacts of Other Alternatives 6-56
6.5.7 Impacts of EPA Alternatives 6-56

6.6 SOCIO-ECONOMICS AND LAND USE 6-56
6.6.1 Existing Conditions 6-56
6.6.2 Projections 6-59
6.6.3 Impacts of the No Action Alternative 6-72
6.6.4 Impacts of Collection Alternatives 6-72
6.6.5 Impacts of Treatment Alternatives 6-76
6.6.6 Impacts of Sludge Management Alternatives 6-76
6.6.7 Impacts of Other Alternatives 6-76
6.6.8 Impacts of EPA Alternatives 6-78

6.7 ENERGY AND OTHER RESOURCES 6-78
6.7.1 Existing Conditions 6-79
6.7.2 Impacts of the No Action Alternative 6-79
6.7.3 Impacts of Collection Alternatives 6-79
6.7.4 Impacts of Treatment Alternatives 6-80
6.7.5 Impacts of Sludge Management Alternatives 6-80
6.7.6 Impacts of Other Alternatives 6-83
6.7.7 Impacts of EPA Alternatives 6-84

6.8 SUMMARY OF ADVERSE IMPACTS, ENVIRONMENTAL TRADEOFFS AND RESOURCE COMMITMENTS 6-84
6.8.1 Adverse Impacts Which Cannot Be Avoided 6-84
6.8.2 Short-term Uses of the Environment Versus Long-term Productivity 6-86
6.8.3 Irreversible and Irretrievable Commitments of Resources 6-86

7. COORDINATION 7- 1

7.1 PUBLIC PARTICIPATION PRIOR TO RELEASE OF DRAFT EIS 7- 1
7.2 MAJOR ISSUES IDENTIFIED DURING THE PUBLIC PARTICIPATION PROCESS 7- 2
7.3 ON-GOING COORDINATION 7- 5

Page

8. LIST OF PREPARERS 8- 1

9. BIBLIOGRAPHY 9- 1

10. GLOSSARY 10- 1

10.1 COMMON ABBREVIATIONS (ACRONYMS) 10- 1
10.2 TECHNICAL TERMS 10- 1
10.3 METRIC CONVERSIONS 10-11

LIST OF APPENDICES

A. EXISTING WASTEWATER MANAGEMENT A- 1
B. INFORMATION RELATED TO SELECTION OF ALTERNATIVES B- 1
C. SUPPLEMENTAL COORDINATION C- 1

INDEX I- 1

List of Figures

3-1 Canadian River Basin, Norman to Kerr Reservoir 3- 2
3-2 Location Map: Little River Basin 3- 3

4-1 Existing Collection System and Service Area 4- 2

5-1 COMPLAN Tiers 5- 4
5-2 Existing and Proposed Service Area Basins, Year 2000 5- 5
5-3 Proposed Sewerage Improvements 5-11
5-4 Existing and Proposed Interceptor, Bishop Creek Service Area 5-16
5-5 Sludge Disposal 5-35

6-1 Natural Regions 6- 3
6-2 Flood Hazard Areas 6-11
6-3 Route of Proposed Basin A & B Interceptors 6-12
6-4 Route of Proposed Basin C Interceptor 6-13
6-5 Route of Proposed Basin D Interceptor 6-14
6-6 ACOG Drainage Basins 6-23
6-7 Oliver Wildlife Preserve 6-49
6-8 Existing Land Use, Norman 6-58
6-9 Proposed COMPLAN Development Tiers 6-60
6-10 Proposed Land Use, Norman Urban Area 6-66
6-11 Prime Agricultural Lands and Additional Agricultural Land of Local and Statewide Importance 6-70

List of Tables

Page

1-1 Ranking of Wastewater Treatment Alternatives 1- 5
1-2 Summary of Evaluation of Sludge Management Alternatives 1- 6
1-3 Summary of Impacts of the Applicant's Probable Preferred Alternative 1- 9

3-1 Interagency Coordination Responsibilities 3- 7

4-1 Projected Wastewater Flows 4- 3
4-2 Water Quality Criteria by Beneficial Use 4- 8
4-3 Alternative Wasteload Allocations and Treatment Levels 4-11

5-1 Cost of Proposed Collection System 5-14
5-2 Potential Environmental Impacts of Construction Activities 5-23
5-3 Possible Construction Impact Mitigation Measures 5-25
5-4 Cost Summary of the Seven Treatment Alternatives 5-28
5-5 Ranking of Wastewater Treatment Alternatives 5-29
5-6 Summary of Costs of Sludge Management Alternatives 5-37
5-7 Comparison of Sludge Management Alternatives 5-38
5-8 Estimated Sewer Use Fees to Fund Proposed Wastewater Facilities 5-49

6-1 Generalized Environmental Characteristics of Natural Regions in the Norman Area, Oklahoma 6- 4
6-2 Water Quality of Lake Thunderbird Near the Dam 6-17
6-3 Water Quality of Lake Thunderbird, Little River Inlet 6-18
6-4 Quality of Storm Runoff in the Central Oklahoma Area 6-21
6-5 Results of ACOG Urban Runoff Modeling, Little River Basin Norman, Oklahoma 6-22
6-6 Results of ACOG Urban Runoff Modeling, South Canadian River Basin, Norman, Oklahoma 6-25
6-7 Estimated Annual Sediment and Nutrient Loadings to Lake Thunderbird Under Existing (1975) Land Use Conditions 6-26
6-8 Estimated Annual Sediment and Nutrient Loadings from the ACOG Region into the Canadian River Under Existing (1975) Land Use Conditions 6-28
6-9 Modeled Quality of the South Canadian River for Alternative Levels of Wastewater Treatment 6-36
6-10 Oklahoma Air Quality Standards and Increments 6-40
6-11 Noise Levels and Guidelines 6-42
6-12 Emission Factors for Sludge Incinerators 6-46
6-13 Phased Growth Concept 6-61
6-14 Division of a Typical Planned Residential Section by Major Land Use Categories 6-62
6-15 Population Sewer Service Basins - Norman, Oklahoma 6-64
6-16 Projected Population by Development Tier 6-65
6-17 Projected Land Development by Basin - Norman, Oklahoma 6-67
6-18 Land Use in Little River Basin - 1977 and 2000 6-69
6-19 Land Requirements for All Alternatives 6-77

Page

6-20 Energy and Chemical Usage of the Seven Treatment Alternatives 6-81
6-21 Net Energy Requirements for the Sludge Management Alternatives 6-82
6-22 Summary of Impacts of the Applicant's Preferred Alternative 6-85

7-1 Agencies and Organizations to Whom the Draft EIS Will Be Distributed 7- 7

CHAPTER 3

INTRODUCTION

3. INTRODUCTION

3.1 BACKGROUND ON APPLICANT AND APPLICATION

The city of Norman is located in Cleveland County in central Oklahoma, just south of Oklahoma City. Norman's population is given as 68,020 persons in the preliminary 1980 census; rapid growth is occurring in Norman and adjoining areas. As illustrated in figure 3-1, Norman lies in the drainage basin of the South Canadian River. Figure 3-2 shows that most of the area inside the city limits is undeveloped acreage within the Little River basin, a tributary of the South Canadian. The Little River watershed provides runoff to Norman's main water-supply reservoir, Lake Thunderbird. This basin is considered environmentally sensitive because of the risk that urbanization in the watershed could adversely affect water quality in the reservoir. The remainder of Norman, including most urban sections, drains directly to the South Canadian. The wastewater collection system drains or is pumped to a single treatment plant which discharges to the South Canadian River (see figure 4-1 in chapter 4).

The city of Norman is preparing a facilities plan to evaluate alternative improvements to its wastewater collection and treatment system. This work is being performed under Grant No. C-40-0899-01-0 from the U.S. Environmental Protection Agency (EPA), which provides 75 percent of the funds for portions of the study which are eligible. The facilities plan was begun in May, 1978 and is being prepared by Painter and Spitz, Inc., an engineering firm located in Oklahoma City, Oklahoma; a draft facilities plan was completed in August, 1981.

The corporate limits of Norman constitute the planning area designated for detailed study. For purposes of evaluating environmental impacts, especially regarding water quality and supply, it is also necessary to consider regions which drain to or receive drainage from the planning area. Thus the Canadian and Little River drainage basins shown in figure 3-1 can be considered part of the project study area. Certain properties not under Norman's jurisdiction are excluded from direct consideration in the facilities plan, except as they impact Norman's wastewater facilities at their property line. These properties are Central State Hospital; the University of Oklahoma; Max Westheimer Field; the community of Hall Park; and Little River State Park. Figure 3-2 shows the boundaries of Norman, Hall Park and the Little River State Park; locations of the remaining excluded areas are shown in figure 4-1. Figure 3-2 also shows major hydrologic features (reservoirs, tributaries), political boundaries, and areas where urban development now exists or is projected to occur in the foreseeable future.

One of the major wastewater problems in Norman is the Bishop Creek interceptor, which serves much of the east side of the urban area. Norman proposed and EPA approved the construction of a portion of this sewer system prior to completion of the remainder of the facilities plan. Eligibility of the line

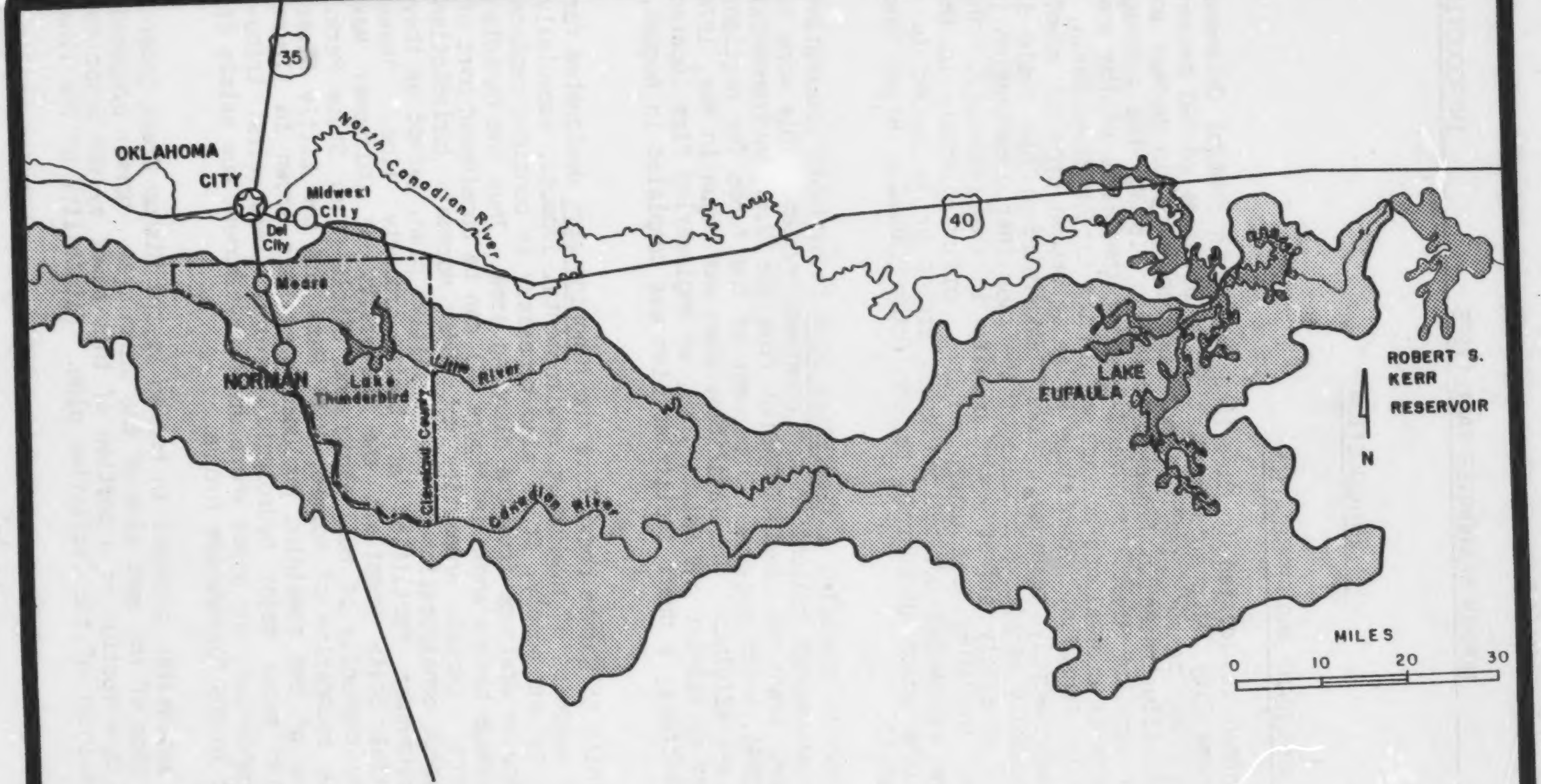
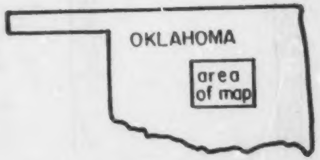
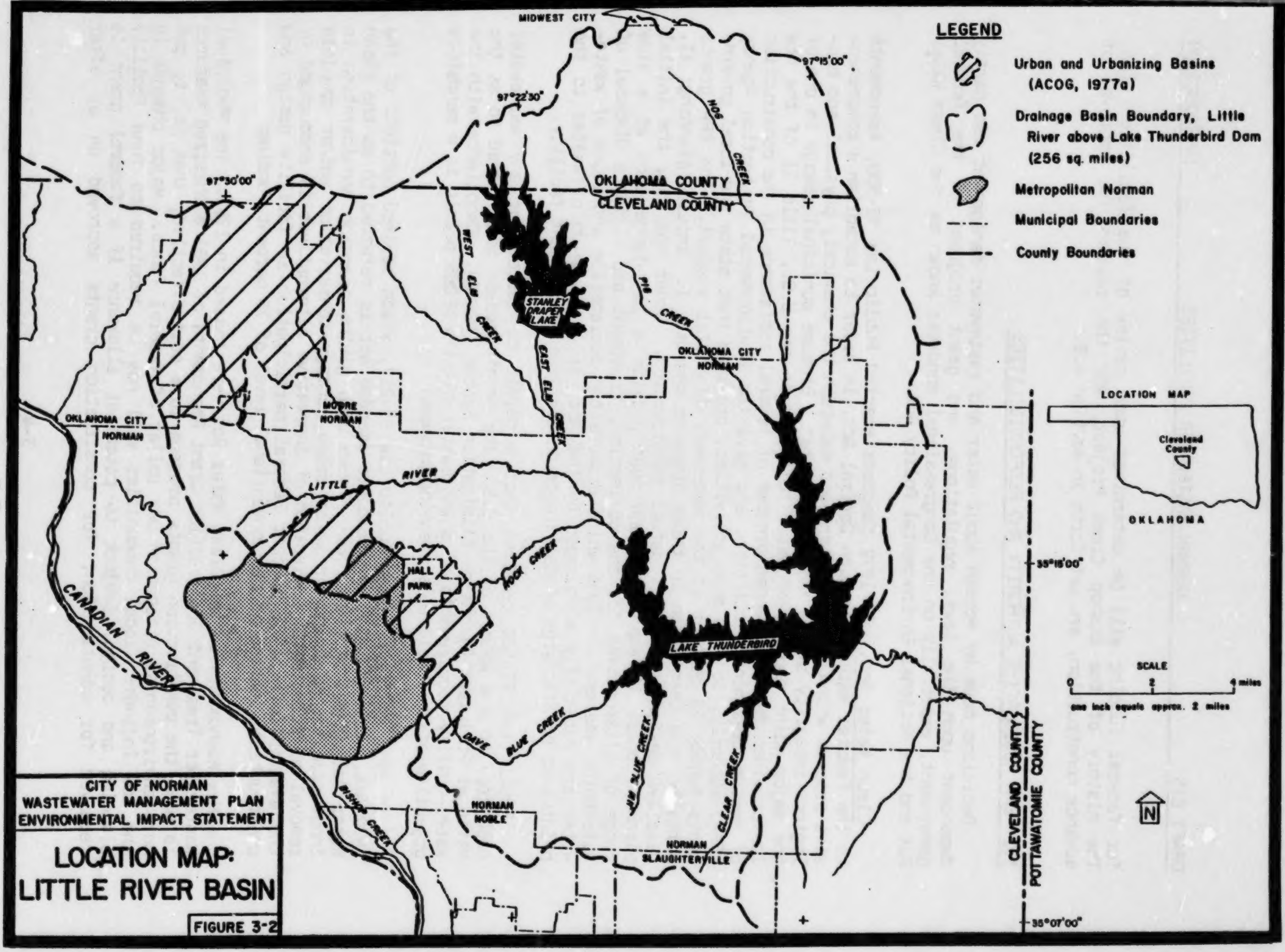

35
OKLAHOMA CITY
Del City
Midwest City
North Canadian River
40
Moore
NORMAN
Lake Thunderbird
Little River
Cleveland County
Canadian River
LAKE EUFAULA
ROBERT S. KERR RESERVOIR
N
MILES
0
10
20
30

FIGURE 3-1. CANADIAN RIVER BASIN, NORMAN TO KERR RESERVOIR


OKLAHOMA
area of map

Source: U.S.G.S., Hydrologic Units Map of Oklahoma, 1974.


LEGEND
Urban and Urbanizing Basins (ACOG, 1977a)
Drainage Basin Boundary, Little River above Lake Thunderbird Dam (256 sq. miles)
Metropolitan Norman
Municipal Boundaries
County Boundaries
MIDWEST CITY
97°15'00"
97°22'30"
97°30'00"
HOG CREEK
OKLAHOMA COUNTY
CLEVELAND COUNTY
WEST ELM CREEK
STANLEY DRAPER LAKE
EAST ELM CREEK
PIG CREEK
OKLAHOMA CITY
NORMAN
MOORE
NORMAN
OKLAHOMA CITY
NORMAN
LITTLE RIVER
HALL PARK
ROCK CREEK
LAKE THUNDERBIRD
DAVE BLUE CREEK
JIM BLUE CREEK
CLEAR CREEK
CANADIAN RIVER
BISHOP CREEK
NORMAN
NOBLE
NORMAN
SLAUGHTERVILLE
CLEVELAND COUNTY
POTTAWATOMIE COUNTY
35°15'00"
35°07'00"
LOCATION MAP
Cleveland County
OKLAHOMA
SCALE
0
2
4 miles
one inch equals approx. 2 miles
N

CITY OF NORMAN
WASTEWATER MANAGEMENT PLAN
ENVIRONMENTAL IMPACT STATEMENT

LOCATION MAP:
LITTLE RIVER BASIN

FIGURE 3-2

for federal funding will be determined upon review of the facilities plan. The history of the Bishop Creek Project, and the reasons for approval of advance construction, are set forth in section 4.2.

3.2 EPA LEGISLATIVE AUTHORITY AND RESPONSIBILITIES

Decisions made by Norman about water and wastewater management are partly dependent upon the laws, regulations, and grant programs of the federal government, especially on the Congressional mandates known as the Clean Water Act and the National Environmental Policy Act.

Clean Water Act. In 1972 Congress enacted Public Law 92-500, Amendments to the Federal Water Pollution Control Act, in order to establish a comprehensive program which would "restore and maintain the chemical, physical and biological integrity of the Nation's waters". Because municipal sewage is one of the major point sources of water pollution in the U.S., Title II of the new law provided for an expanded program of federal assistance in the construction of sewage treatment facilities, and gave the Environmental Protection Agency (EPA) authority to fund such activities, provided that state and local governments supply 25 percent of the necessary financial support. The EPA grants normally have been given in three steps or phases: I. initial planning; II. detailed design; and III. actual construction. Under the law, the initial planning phase is emphasized and must provide a long-range look at a wide range of alternatives for the collection, treatment and ultimate disposal of waterborne wastes. Actions which promote the reclamation and reuse of wastewater are especially encouraged by the Act, as is clean-up of wastes to the point that no discharge of pollutants occurs from a treatment facility.

Public Law 92-500 requires that a permit be issued for any wastewater discharge to the waters of the U.S. The permit system is referred to as the National Pollutant Discharge Elimination System (NPDES). Compliance with the water-quality requirements of a wastewater plant's NPDES permit is a mandatory objective of the facilities planning process.

In 1977 Congress passed Public Law 95-217, which revised portions of the 1972 Act. Collectively, the complete amended act is referred to as the Clean Water Act (CWA). Emphasis was placed upon giving planning consideration to innovative technologies for water reuse, energy conservation and/or complete removal of pollutants. Selection of innovative alternatives is encouraged by the availability of 85 percent Federal participation in facility design and construction, instead of the conventional level of 75 percent funding.

New amendments to the Clean Water Act were passed in 1981. The Municipal Wastewater Treatment Construction Grant Amendments of 1981 emphasized measures to make the construction grants program more cost-effective, that is, to get more environmental protection per dollar of federal funds. Major changes to the law include: local communities will now be required to fund facility planning and design, subject to potential allowance if a federal grant is received for construction; for construction grants approved on or after

October 1, 1984, the federal grant share is reduced to 55%; after October 1, 1984, certain types of facilities (e.g., collection sewers) will no longer be grant eligible, and there will be no funding of reserve capacity (that is, EPA will only pay for a plant big enough to treat wastewater from the population served at the time a construction grant is made); funding is provided for value engineering for large facilities (costing more than $10 million), and for the design engineers to continue their relationship with the project for one year to facilitate operation during the break-in period; oxidation ponds, lagoons and ditches, and trickling filters are deemed the equivalent of secondary treatment when water quality will not be adversely affected.

The act also contains a number of specific provisions associated with the new approach to funding, and mandates that funding priorties be established in terms of water-quality benefits.

National Environmental Policy Act (NEPA). NEPA is Public Law 91-190, and was signed in 1969. There are six specific environmental objectives of federally-funded actions, set forth in section 101(b) of NEPA as follows.

1. To fulfill the responsibilities of each generation as trustee of the environment for succeeding generations.

2. To assure for all Americans safe, healthful, productive and aesthetically and culturally pleasing surroundings.

3. To attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable or unintended consequences.

4. To preserve important historic, cultural, and natural aspects of our national heritage, and maintain, wherever possible, an environment which supports diversity, and variety of individual choice.

5. To achieve a balance between population and resource use which will permit high standards of living and a wide sharing of life's amenities.

6. To enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources.

NEPA also provides that an Environmental Impact Statement (EIS) be prepared by federal agencies which propose a major action that significantly affects the quality of the human environment. The EIS must provide information to be used in federal decision-making. Section 102(2)(c) of NEPA requires the EIS to consider:

a) the environmental impact of the proposed action;
b) any adverse environmental effects which cannot be avoided should the proposal be implemented;
c) alternatives to the proposed action;

d) the relationship between local short-term uses of the environment and the maintenance and enhancement of long-term productivity; and
e) any irreversible and irretrievable commitments of resources which would be involved due to the implementation of the proposed action.

EPA's decision to prepare an EIS on the Norman project is discussed in chapter 4. Based on the most recent regulations regarding EIS preparation (CEQ, 1978; EPA, 1979), the document is to concentrate on key issues as determined through an early public "scoping" process, and as further defined during an extensive public participation process. The public participation program normally includes the formation of a Citizens Advisory Committee of local citizens to review and provide advice in the facilities plan and EIS processes. The EIS must provide a concise analytical statement, usually of less than 150 pages, concentrating on evaluation of real alternatives.

The EIS process includes cooperation with all federal and state agencies which have management responsibilities for key environmental resources. Table 3-1 lists agencies normally concerned with wastewater projects in Oklahoma. Chapter 7 documents the public participation program during EIS preparation and describes the process of coordination and review which will apply to this Draft EIS. A chapter of the Final EIS will include all public comments on the Draft, and EPA's responses to these comments.

3.3 INVOLVEMENT OF OTHER AGENCIES

In addition to the general coordination associated with any wastewater EIS (table 3-1), EIS preparation mandates consideration of project-related decisions which may be made by governments or agencies other than EPA. In the specific case of Norman, several agencies are involved in water quality management. The Oklahoma Water Resources Board (OWRB) establishes water quality standards for streams and rivers in Oklahoma. Water-quality management plans are prepared by the Oklahoma Department of Pollution Control (ODPC). Wasteload allocations for the Norman area are being developed by the Association of Central Oklahoma Governments (ACOG); the allocations determine effluent limits for Norman's wastewater discharge, in order that the water quality standards will be met in the receiving water (South Canadian River). The Oklahoma State Department of Health (OSDH) issues a State wastewater discharge permit similar to the NPDES permit; OSDH also administers State sludge handling requirements and monitors wastewater facilities planning requirements.

TABLE 3-1. INTERAGENCY COORDINATION RESPONSIBILITIES.

While all coordination needs to be documented in the EIS, items with an asterisk (*) represent major, mandatory elements of the consultation process.

EPA Coordination Responsibilities [a]	Coordinating Agencies and Responsibility	Authority
HISTORICAL AND ARCHEOLOGICAL SITES		
Request identification of properties listed on or eligible for listing on the National Register of Historic Places that may be affected by the undertaking.* Identify effects of undertaking on those properties.	State Historic Preservation Officer; Advisory Council on Historic Preservation; National Park Service: Identify existing and potential Register properties and comment on findings of environmental document.* Undertake data recovery and preservation activities if the undertaking may cause irreparable loss or destruction of significant scientific, prehistoric or archeological data.	National Historic Preservation Act of 1966, as amended; Archeologic and Historic Preservation Act of 1974; Reservoir Salvage Act of 1960; and Executive Order 11593, entitled "Protection and Enhancement of the Cultural Environment."
WETLANDS PROTECTION		
Determine if proposed actions will be in or affect wetlands. If so, prepare a wet lands assessment as part of the environmental document.	None	Executive Order 11990, Protection of Wetlands; EPA's Statement of Procedures on Floodplain Management and Wetlands Protection (January 5, 1979).
FLOODPLAIN MANAGEMENT		
Identify flood hazard areas as they are related to existing and proposed facilities.	Federal Emergency Management Agency: Provide flood hazard maps of the planning area.	Executive Order 11988, Floodplain Management; Flood Insurance Act of 1968; Flood Control Act of 1970; National Flood Disaster Protection Act of 1973; refer also to Wetlands Protection.
Request preliminary determination of need for permits for construction in a waterway, as relate to dredge and fill activities.	U.S. Army Corps of Engineers: Comment on findings of environmental document as may relate to Corps projects; indicate likelihood of need for Section 404 or Section 10 permits.	Section 404 of Clean Water Act of 1972; Section 10 of the Rivers and Harbors Act of 1899.
AGRICULTURAL LANDS		
Request identification of significant agricultural lands in the planning area. Evaluate impacts of the proposed action and recommend mitigation measures.	State and/or Area Conservationist, U.S. Soil Conservation Service: Identify significant agricultural lands, such as reported in the Important Farmland Inventory.	EPA's Policy to Protect Environmentally Sensitive Agricultural Lands (September 8, 1978).
WILD AND SCENIC RIVERS		
Request identification of designated or nominated Wild, Scenic or Recreational rivers under the Wild and Scenic Rivers Act. Identify and avoid all impacts to such rivers.	National Park Service; State Scenic Rivers Administrator; Bureau of Land Management; U.S. Forest Service: Identify Wild and Scenic rivers. Comment on findings of environmental document.	Wild and Scenic Rivers Act of 1968; Water Resources Planning Act of 1965.
FISH AND WILDLIFE		
Identify and determine impacts to flora and fauna and to any natural stream or body of water and consult with reviewing agency on mitigating, preventing or compensating for project-related losses of wildlife and to enhance other resources.	U.S. Fish and Wildlife Service; Oklahoma Department of Wildlife Conservation: Comment on findings of the environmental document.	Fish and Wildlife Coordination Act of 1958.

TABLE 3-1. INTERAGENCY COORDINATION RESPONSIBILITIES. (continued).

EPA Coordination Responsibilities [a]	Coordinating Agencies and Responsibility	Authority
ENDANGERED SPECIES PROTECTION		
Request identification of all designated and proposed endangered or threatened species and critical habitats in the area. Prepare biological assessment of endangered species and/or critical habitats if necessary.	U.S. Fish and Wildlife Service; Oklahoma Department of Wildlife Conservation: Identify endangered species or habitats, including formal review by the Office of Endangered Species if required under Section 7 of the Endangered Species Act.	Endangered Species Act of 1973.
AIR QUALITY		
Assess direct and indirect impacts of the project on air quality. Consult with the state or local agency to ascertain conformity of the action to the State Air Quality Implementation Plan (SIP). Determine if any increased emissions are allowable or will be offset.	Oklahoma State Department of Health: Assist with assessment of project impacts. Respond to request for conformity concurrence.*	Clean Air Act, as amended, 1977.
OTHER: PUBLIC LANDS, NOISE, WATER QUALITY, OTHER STATE AND LOCAL CONCERNS		
Consult with appropriate agencies and assess impacts. Submit draft environmental document to A-95 Clearinghouse for review.[b] Identify NPDES standards and violations, and relationship of project to the Clean Water Act. Assess conformance to Section 208 Areawide Wastewater Management Plan. Assess conformance to other State and local plans, such as recreation and open space, economic development and county and municipal plans.	U.S. Forest Service; U.S. Bureau of Land Management; Oklahoma Water Resources Board; Oklahoma State Department of Health; Oklahoma Department of Pollution Control; Association of Central Oklahoma Governments (ACOG): opportunity for comment on findings of environmental document is required*.	NEPA and Clean Water Act; Noise Control Act of 1972; Federal Insecticide, Fungicide and Rodenticide Act; as amended; Resource Conservation and Recovery Act; Toxic Substances Control Act; Safe Drinking Water Act; Office of Management and Budget Circular A-95.

---

a. EPA refers to persons acting on behalf of EPA or the grantee.
b. Office of Management and Budget Circular A-95 requires that State and areawide "clearinghouses" coordinate Federally-funded projects.

Sources: EPA, 1979. Implementation of procedures on the National Environmental Policy Act. 44FR 64174-64193, Nov. 6, 1979, 40 CFR Part 6.
EPA Region 6, 1978. Instruction for preparing environmental assessments for construction grants projects. CG-99, revised 11/8/78.
Spotts, Clinton B., August 1979. Working guidelines for the preparation of environmental impact statements.
EPA, 1979. Environmental assessment of construction grants projects. EPA-430/9-79-007.

CHAPTER 4

PURPOSE AND NEED

CHAPTER 4. PURPOSE AND NEED

4.1 PROBLEMS WHICH NEED TO BE ADDRESSED

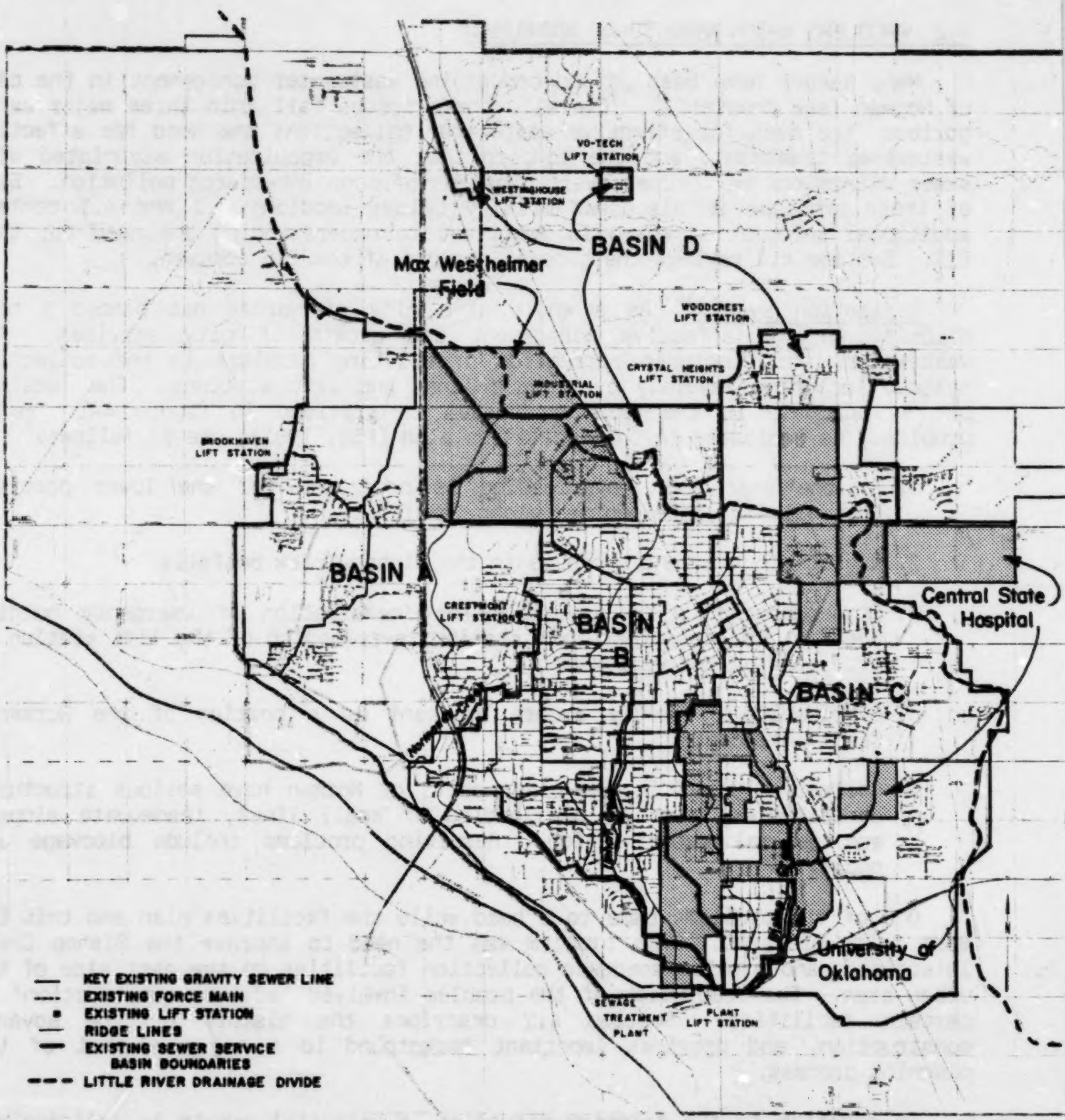
Many issues have been raised concerning wastewater management in the city of Norman (see chapter 7). Overall, these issues fall into three major categories: the need for effective wastewater collection; the need for effective wastewater treatment; and the concern that the urbanization associated with sewer extensions may cause severe problems of nonpoint-source pollution. Each of these problems is discussed briefly below; sections 4.2 and 4.3 contain additional information which is important to understanding the need for this EIS. Section 4.4 reviews the general purpose of the EIS document.

Collection system. As a whole, the city of Norman has placed a high priority on the effective management and growth of city services. For wastewater, this includes correction of existing problems in the collection system, including severely overloaded lines and lift stations. The location of key elements in the existing system is provided in figure 4-1. Major problems, as indicated in the facilities plan (PSC, 1981), are as follows.

1. By the year 2000, overloading is projected for the lower portions (outfalls) of interceptors along Imhoff Creek.
2. Overloading currently occurs in the Bishop Creek outfalls.
3. Inadequate space is available for installation of emergency holding ponds at the Woodcrest lift station; overloading of the lift station is projected by the year 2000.
4. Overloading currently occurs adjacent to a portion of the Normandy Creek interceptor.
5. Collection lines in the older parts of Norman have serious structural deficiencies, such as overloading of small lines, inadequate slopes, and general deterioration. Resulting problems include blockage and odors.

One of the problems came to a head while the facilities plan and this EIS were being prepared. This problem was the need to improve the Bishop Creek interceptor and provide adequate collection facilities on the east side of the urban area. The resolution of the problem involved 'advance construction' of certain facilities. Section 4.2 describes the history of the advance construction, and provides important background to a major element of the planning process.

In addition to the existing situation, substantial growth is anticipated. Table 4-1 shows how the population and wastewater flow from the service area are projected to increase over time. By 2000, the service area would contain 100,800 persons contributing to the collection system. Coupled with


VO-TECH LIFT STATION
WESTINGHOUSE LIFT STATION
BASIN D
Max Westheimer Field
WOODCREST LIFT STATION
CRYSTAL HEIGHTS LIFT STATION
INDUSTRIAL LIFT STATION
BROOKHAVEN LIFT STATION
BASIN A
CRESTMONT LIFT STATION
BASIN B
Central State Hospital
BASIN C
University of Oklahoma
SEWAGE TREATMENT PLANT
PLANT LIFT STATION
KEY EXISTING GRAVITY SEWER LINE
EXISTING FORCE MAIN
EXISTING LIFT STATION
RIDGE LINES
EXISTING SEWER SERVICE BASIN BOUNDARIES
LITTLE RIVER DRAINAGE DIVIDE

Source: PSC, 1981.

FIGURE 4-1. EXISTING COLLECTION SYSTEM AND SERVICE AREA

TABLE 4-1. PROJECTED WASTEWATER FLOWS.

Year	Population in Service Area [a]	Total Average Flow Gallons/day [b]	Total Flow Acre-feet/year
1980	66,866	6,318,837	7,078
1985	83,140	8,514,000	9,537
1990	96,480	9,648,000	10,807
1995	98,640	9,864,000	11,049
2000	100,800	10,080,000	11,291

a. Remainder of planning area population would be served by on-site wastewater systems.
b. Refer to Glossary for definition.

Source: PSC, 1981.

industrial sources, these residents would produce 10 million gallons per day (mgd) of wastewater. Most of the growth will occur to the east and northeast of the established urban core. Sewer service to this area must be provided in a manner consistent with the city land-use plan (see section 6.6.1), which encourages compact, orderly growth based on phased extension of utilities into areas designated for new development.

Treatment system. The effective management of City services also requires solutions to problems at the existing wastewater treatment plant (see figure 4-1 for location). According to the facilities plan, there are two major problems at the plant.

1. The treatment plant has an organic loading capacity of 10,560 pounds of biochemical oxygen demand (BOD) per day, versus an existing loading rate of 15,000 to 16,000 pounds of BOD per day. An analysis of individual treatment units indicates that the secondary filter system performs poorly and the aerated lagoon-final clarifier system is inefficient. Because of these problems, the effluent discharged to the South Canadian River contains an average BOD of 22 milligrams per liter (mg/l), which is 2 mg/l above the permitted limit. The projected population growth will add to the BOD loading, and to the potential that effluent discharges will exceed standards.

2. The sludge digesters are presently operating near their full capacity, and current sludge disposal practices do not conform with EPA regulations.

In order to understand how these problems might be solved, it is important to consider the regulations which apply to future wastewater discharges in the region. Information on this subject is provided in section 4.3.

Nonpoint-source pollution. As discussed in chapter 7, the citizens of Norman assign a very high priority to the full protection of water resources, especially the city's own drinking water. The major water supplies are Lake Thunderbird and ground water in one major and two minor aquifers (see section 6.2.2). During EIS preparation, the most debated issue has been the extent to which urbanization in the Little River watershed would adversely affect Lake Thunderbird because of toxic chemicals, algal blooms, excessive sedimentation or other changes. Since the EIS must consider both urbanization (as related to sewer extensions) and water quality, this planning process presents an opportunity to bring the issue before the public. Similar issues apply to other types of water resources, such as the ecologically important floodplain of the South Canadian River.

The concerns over Lake Thunderbird can be illustrated by noting that in 1974 the city began to construct lift stations in the Little River watershed; the U.S. Environmental Protection Agency (EPA) funded the project. This action led to extensive public controversy over the potential that the lift stations would promote or allow growth in the watershed, and the consequent risk that Lake Thunderbird would become polluted. In response, EPA prepared an Environmental Impact Statement to evaluate the proposed funding (EPA, 1977a).

In the 1977 EIS, the "No Action" alternative was selected by EPA in order to "mitigate and conceivably eliminate the significant adverse secondary water-quality impacts (nutrient buildup, algal blooms, eutrophication, nonpoint discharge of toxic pollutants) on Lake Thunderbird associated with the development of the unurbanized area". This decision resulted in withdrawal of federal funds and the end of the project, even though engineering for both primary lift stations had been completed prior to work stoppage, as had excavation of one station site and construction of one gravity line segment. The completed segment is near the Norman water treatment plant just south of Hall Park. Contractors were compensated by a joint action of the city and EPA. The city then submitted an application to EPA and OSDH for a facilities planning grant for the entire Norman wastewater system. The grant was made; it is under that grant that the facilities plan and this EIS were prepared.

At this time, the situation has changed from that in 1977, in that the city of Norman now has an adopted Comprehensive Plan (COMPLAN), which aims to balance a wide range of environmental and other factors important to the growth of the city, and which provides clear guidance as to the extent to which collection lines should be extended into the Little River basin (see discussion of plan, section 6.6.1). Consequently, the emphasis of the facilities plan is to identify the most effective means of providing such extensions, rather than to consider whether or not such extensions are appropriate.

Nonetheless, the prospect of such extensions raises questions similar to those asked in the mid-1970's, such as: what is the risk to Lake Thunderbird if the upstream watershed becomes urbanized? The answer could influence long-range decisions regarding watershed management in Norman and adjoining communities, even though it may not determine more immediate decisions about sewer line policies. Thus, this EIS does identify potential problems in Lake Thunderbird which may arise as the COMPLAN is implemented. The analysis provided in the EIS is taken from a separate report (LWA, 1982a), which evaluates how land use changes might effect water quality in Lake Thunderbird. The report, which was prepared concurrently with the EIS, will be available to the public hearing on the EIS.

Summary. The primary focus of the Norman facilties plan is to solve existing problems in the collection and treatment system, and to provide additional capacity for the year 2000. To address these issues, the planning process has evaluated a variety of alternative wastewater treatment facilities of appropriate size, location and technology. The environmental effects of these alternatives are considered in chapter 5 of this EIS, with more detailed supporting information provided in chapter 6. In addition, the EIS reviews the issue of nonpoint-source pollution in the Little River basin, in order to provide guidance as to the long-term management of Lake Thunderbird and its watershed.

4.2 ADVANCE CONSTRUCTION OF BISHOP CREEK INTERCEPTOR

History of problem. The collection system in the Norman urban area is divided into sewerage drainage basins (see figure 4-1). The Bishop Creek basin, basin C, collects wastewater from the eastern portion of the urban area into an interceptor system which generally follows the natural drainage of Bishop Creek. The Bishop Creek interceptor also conveys wastewater from portions of the Little River basin (basin D) known as the Woodcrest Addition. This wastewater is pumped into the interceptor by the Woodcrest lift station, to prevent wastewater discharges into the Lake Thunderbird drainage.

In 1975, the city of Norman discovered serious overloading of the Bishop Creek interceptor on a daily basis. Possible causes of the problem included groundwater infiltration, stormwater inflow, and excessive flows from Central State Hospital. Late in 1975, the Norman City Council informally adopted a policy of denying approval of any subdivision of land which would eventually involve hookups to the Bishop Creek interceptor. The informal policy was formalized in February of 1979 through Council resolution. By that time, no capacity existed for flows generated by new houses on already platted land and for expansion projects on already developed lots. Also, the capacity problem resulted in backups to smaller collection lines. The moratorium was established only until the Bishop Creek interceptor could be suitably improved, or for a maximum of five years.

The Woodcrest Addition has a history of overflows dating back to the early seventies. In May 1979, the city of Norman concluded that an interim solution was needed to prevent the backup of raw sewage to homes and drainages in the Lake Thunderbird watershed. In an attempt to eliminate the overflows, the city expanded the capacity of the Woodcrest force main enough to carry peak flows. Also, the city constructed a temporary detention pond at the discharge end of the force main to prevent further overloading of the Bishop Creek outfall. Construction on the force main and detention pond was completed in November of 1979.

Overflow problems continued throughout the Bishop Creek system. Complaints centered on odors, debris and sewage solids that surface from three overflowing sewer-access holes into public walkways in Norman's Eastwood Park. Although instances of public health problems resulting from contact with the sewage have not been recorded, both the Oklahoma State Department of Health and the Cleveland County Health Department identified the overflows as a public health hazard.

History of solution. In May, 1980, citizens in the Bishop Creek drainage area were successful in litigation against the city. The U.S. District Court rendered judgment against the city for $4,590,830, ordered and directed this sum to be used for construction of relief sewer lines in the Bishop Creek Sewer Moratorium area, and ordered a specific schedule for project construction. The Court stated that the current overloaded condition of the line "poses a clear and present danger to the health, safetv, and general welfare of the plaintiffs and all members of the class represented by the plaintiffs."

The specific measures ordered by the Court included twelve separate sewer lines within the Bishop Creek area. The city intends to comply fully with the Court Order, and has completed the first portion of the Court-mandated schedule, which involved the construction of the largest and southernmost line in the system. Completion of the remaining court-ordered lines will alleviate the existing emergency situation.

Advance construction approval. EPA has special procedures whereby, under narrowly defined circumstances, wastewater facilities may receive approval for construction in advance of the completion of an EPA-funded facilities plan. When a portion of a project is considered for advance construction approval, EPA must also segment the environmental review of that portion from the EIS. Among the requirements for such segmentation are: the project must be needed to correct an immediate environmental problem; the project must be a minor, discrete, noncontroversial portion of the facilities plan which does not foreclose reasonable alternatives to be considered in the remainder of the area; and completion of the segment must be necessary to correct overriding considerations of costs or program effectiveness. At the time that the Norman advance construction request was being considered, EPA was required to consult with the President's Council on Environmental Quality (CEQ) regarding segmentation of the environmental review.

Projects which receive advance construction approval may be constructed before award of a construction grant, without penalty. The approved facilities are potentially eligible for EPA funding. However, final eligibility will not be determined until award of the construction grant; the approval conveys no guarantee of funding.

Identifying the Bishop Creek situation as an emergency, the city requested approval from EPA for advance construction of the Bishop Creek relief sewers project. The city submitted an Environmental Information Document (EID) describing the environmental impacts related to the project (LWA, 1980; that reference presents a detailed history of the problem). After review of the submittals, EPA issued a Finding of No Significant Impact, consulted with CEQ, and in December, 1980, announced its decision to approve advance construction of lines C-1 and C-2 (refer to figure 5-3 and table 5-1). EPA then issued an Administrative Order which defined the schedule for completion of the facilities plan and EIS. Violation of the deadlines in this Order will subject the city to the possibility of enforcement actions. Also, EPA required that the building ban continue in the Little River watershed until the EIS is complete.

EPA's decision leaves open possible federal funding for a portion of the cost of the Bishop Creek lines. Such funding could amount to an estimated $2,025,639, which would reduce the local share to an estimated $675,213. However, the request for reimbursement must be made as part of the construction grant application, which in turn requires completion of the facilities plan and EIS. Thus EPA's funding decision will be made on the basis of the overall management program.

Although the advance construction has been evaluated in one environmental document (the EID), it must also be considered in this EIS, since the EIS must consider the entire range of wastewater management actions which have been evaluated in the facilities planning process.

4.3 TREATMENT REQUIREMENTS; WASTELOAD ALLOCATIONS

There are many terms associated with wastewater treatment regulations. Although at first glance they may appear complex, the basic concept is simple: wastewater treatment requirements are based on the need to protect the stream (or other waters) to which the wastewater is discharged. Stream standards and water-quality criteria define the water-quality levels which must be maintained in any particular river reach. Some standards apply to a variety of water bodies; others are tailored to the specific beneficial uses which are made of a particular stream. Criteria for the Norman area are presented in table 4-2.

For any given river where flow conditions are known, it is possible to calculate the extent to which pollutants may be discharged without causing violations of the criteria. This calculation, which establishes an upper limit to pollutant discharges, is known as a wasteload allocation. In turn, the treatment requirements at a given treatment plant must be sufficiently stringent as to ensure that the wasteload allocation is not exceeded. Normally such treatment requirements are stated in terms of effluent standards, which identify the maximum allowable concentrations of various pollutants in the wastewater discharge. These standards are written down in the NPDES permit which EPA issues to each approved point-source discharge.

In Oklahoma, both water-quality criteria and beneficial uses are established by the Oklahoma Water Resources Board (OWRB), using input from the

TABLE 4-2. WATER QUALITY CRITERIA BY BENEFICIAL USE.

All beneficial uses apply to the Canadian River. All but industrial and municipal cooling water apply to Little River above Lake Thunderbird.

Water Quality Constituent	Public and Private Water Supplies	Fish and Wildlife Propagation	Primary Contact Recreation	Agriculture (Livestock and Irrigation)	Secondary Contact Recreation	Aesthetics	Industrial and Municipal Cooling Water
Dissolved oxygen	Aerobic	j/	Aerobic	Aerobic	Aerobic	Aerobic	-
Fecal coliforms	2,000/100 ml	-	200/100 ml	1,000/100 ml	1,000/100 ml	-	-
Color	75 CU	-	-	-	-	75 CU	-
Taste and odor	c/	c/	-	-	-	c/	-
Temperature	d/	d/					
pH	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	-	-	5.0-8.9
Oil and grease	e/	e/	e/	e/	e/	e/	e/
Suspended solids	-	i/	-	-	-	-	5,000
Turbidity	-	i/	-	-	-	-	-
Dissolved solids	-	h/	-	h/	-	-	1,000
Chloride	250	h/	-	-	-	-	-
Sulfate	250	h/	-	-	-	-	-
Nitrate nitrogen	10 mg/l	-	-	100 mg/l	-	-	-
Phosphate (total)	-	f/	-	-	-	0.05 mg/l	-
Nitrogen/phosphate ratio	-	f/					
Toxic substances	g/	g/	Free from	g/	-	Free from	-
Pesticides	Not toxic or carcinogenic	Not toxic or carcinogenic	Not toxic or carcinogenic	Not toxic or carcinogenic	- -	- -	- -
Radioactive materials	k/	k/	-	k/	-	-	-
Ammonia	-	0.2 mg/l a/	-	-	-	-	-
Arsenic	0.5 mg/l b/	0.05 mg/l a/	-	0.1 mg/l	-	-	-
Barium	1.0 mg/l b/	1.0 mg/l a/	-	-	-	-	-
Cadmium	0.01 mg/l b/	0.01 mg/l a/	-	0.01 mg/l	-	-	-
Chlorine	-	0.007 mg/l	-	-	-	-	-
Chromium (hexavalent)	0.05 mg/l a/		-	-	-	-	-
Chromium (total)	0.05 mg/l b/	0.375 mg/l a/	-	0.1 mg/l	-	-	-
Copper (total)	1.0 mg/l b/	0.01 mg/l a/	-	0.2 mg/l	-	-	-
Fluoride	1.6 mg/l b/	1.4 mg/l a/	-	-	-	-	-
Iron (filterable)	0.3 mg/l a/	-	-	-	-	-	-
Lead	0.5 mg/l b/	0.12 mg/l a/	-	0.2 mg/l	-	-	-
Manganese	-	0.05 mg/l a/	-	-	-	-	-
Mercury	0.002 mg/l b/	0.002 mg/l a/	-	-	-	-	-
Nickel	-	0.4 mg/l a/	-	-	-	-	-
Selenium	0.01 mg/l b/	0.01 mg/l a/	-	-	-	-	-
Silver	0.5 mg/l b/	0.000215 mg/l a/	-	-	-	-	-
Sulfides	-	2.0 mg/l a/	-	-	-	-	-
Zinc	5.0 mg/l b/	0.6 mg/l a/	-	2.0 mg/l	-	-	-
Cyanide	0.2 mg/l b/	0.014 mg/l a/	-	-	-	-	-
Detergents (total)	0.2 mg/l b/	-	-	-	-	-	-
Detergents (ABS)	-	0.35 mg/l a/	-	-	-	-	-
Phthalate esters	0.003 mg/l b/	0.365 mg/l a/	-	-	-	-	-
Methylene blue active substances	0.5 mg/l b/	-	-	-	-	-	-
PCBs	-	0.00075 mg/l a/	0.3 mg/l	-	-	-	
Phenolic compounds	-	1.25 mg/l a/	-	-	-	-	-
Carbon chloroform extract	0.15 mg/l a/	-	-	-	-	-	-
2,4-D	0.1 mg/l a/	-	-	-	-	-	-
2,4,5-T	0.1 mg/l a/	-	-	-	-	-	-
Suspended, settleable, or floating materials	-	Free from	Free from	Free from	-	-	-
Benthic diversity	- -	1 unit decrease	- -	- -	- -	- -	- -

TABLE 4-2. Continued.

a. Oklahoma State Planning Standard.
b. Oklahoma State Standard.
c. Taste- and odor-producing substances shall be limited to concentrations that will not interfere with the production of a potable water supply or produce abnormal flavors, colors, tastes, and odors in flesh or other edible wildlife or result in offensive odors in the vicinity of the water, or otherwise interfere with beneficial uses.
d. Increase in temperature of receiving body shall not exceed 5 F in streams or 3 F in lakes. Maxiumum temperature shall not exceed 68 F in trout streams, 84 F in small-mouth bass streams, or 90 F in all other streams and lakes. Normal daily and seasonal variations that were present before the addition of heat from other than natural sources shall be maintained.
e. Free of oil and grease to prevent a visible film of oil or globules of oil or grease on or in the water. Oil and grease shall not be present in quantities that adhere to stream banks and coat bottoms of watercourses, or which cause deleterious effects to the biota. For public and private water supplies, the water shall be maintained free from oil and grease and taste and odors that emanate from petroleum products.
f. The total phosphorus and nitrogen/phosphorus concentration ratio shall be limited to prevent eutrophication problems.
g. Waters must not be toxic to humans, fish and wildlife, and other terrestrial and aquatic wildlife, nor detrimental to any beneficial use, including ingestion by livestock or use for irrigation. Toxic substances shall not be present in quantities which allow significant bioaccumulation and/or biomegnification in the food chain.
h. Chlorides, sulfates, and total dissolved solids shall not exceed the historical "yearly mean standard." Increased mineralization from other elements such as calcium, magnesium, sodium, and their associated anions, etc., shall be maintained at or below a level that will not restrict any beneficial use.
i. Turbidity from other than natural sources shall not exceed 50, 25, or 10 NTU for warm-water streams, warm-water lakes, or cold-water streams, respectively. Where background turbidity exceeds these values, turbidity from point sources shall be restricted to not exceed the naturally occurring background.
j. Dissolved oxygen concentrations shall not be less than 5.0 mg/l for all warm waters and 6.0 mg/l for small-mouth bass or trout fisheries.
k. There shall be no discharge of radioactive materials in excess of the limits found in Oklahoma Radiation Protection Regulations, 1969, or its latest revision.
l. Settleable and suspended solids should not reduce the depth of the compensation point for photosynthetic activity by more than 10 percent from the reasonably established name for aquatic life.

Source: ACOG, 1981a.

other agencies. For the Norman planning area, the Association of Central Oklahoma Governments (ACOG) is responsible for recommending beneficial use levels to the OWRB. ACOG is also charged with determining wasteload allocations, which are then used by the Oklahoma State Department of Health (OSDH) and EPA as the basis for establishing effluent standards. The OSDH has the ultimate responsibility to establish effluent standards for the ACOG planning area. The OSDH will continue the work initiated by ACOG and, working with the OWRB, derive final effluent limitations for the Norman discharge.

At present, definite effluent standards for Norman cannot be determined because of uncertainties about future beneficial-use requirements and water-quality criteria. The following are major causes of the uncertainty.

1. Beneficial uses of the Canadian River include designation as a warm-water fishery, even though actual habitat value is limited by high temperatures and intermittant flows. Based on a wasteload allocation study performed by ACOG (1981), protection of this use would require Norman to meet more stringent effluent limits than now apply; in particular, the city would need to reduce the amount of ammonia discharged to the river. However, ACOG has recommended to OWRB that the benefical use designation for the Canadian be changed, such that ammonia removal would not be required. Thus, the need for ammonia control at the Norman treatment plant has yet to be determined.

2. The ACOG study also contains water quality modelling of the Canadian River, which indicates that the level of treatment which is now required cannot prevent violations of existing stream standards, such as dissolved oxygen. Again, this could lead to more stringent treatment requirements than now apply, with respect to BOD and dissolved oxygen; or there could be a change in the beneficial-use designation which in turn would lead to less stringent stream standards. (The ACOG study indicated that such changes in standards might produce substantial savings in treatment costs at small environmental cost.)

In summary, the specific treatment requirements to be imposed on Norman cannot be determined at this time. To deal with this uncertainty, the OSDH and EPA have required that the facilities plan evaluate treatment alternatives for a variety of potential wasteload allocations. These allocations, listed in table 4-3, correspond closely to the wasteload allocation alternatives evaluated by ACOG. Some minor differences exist between the various treatment levels evaluated in the facilities plan, and the treatment levels defined by ACOG. This is because levels considered in the Plan were established prior to completion of the ACOG report, in order to allow facilities planning to proceed in a timely manner.

The current effluent standards require secondary treatment of Norman wastewater (see Glossary, chapter 10, for definition). This same level of treatment is sufficient to meet ACOG's interim recommendation with respect to protection of the Canadian River. In table 4-3, secondary treatment is

TABLE 4-3. ALTERNATIVE WASTELOAD ALLOCATIONS AND TREATMENT LEVELS.

BOD = five day biochemical oxygen demand; TSS = total suspended solids; all values are in milligrams per liter unless otherwise stated.

ACOG Wasteload Allocation Alternatives, for Wastewater Discharge to the Canadian River	Facilities Plan Treatment Level Alternative Equivalent	Rationale
1. 20 BOD 30 TSS	none	This is the level of treatment (secondary treatment) that the OSDH has determined is necessary to achieve sufficient quality for the beneficial uses of industrial and municipal cooling water and for aesthetics. It does not mandate chlorination, which already exists at the Norman treatment plant.
2. 20 BOD 30 TSS; chlorination to 200 colonies/100 milliliters	A. same as ACOG	In addition to the above beneficial uses this level will allow primary and secondary contact recreation and agricultural uses. This level would meet the requirements of the existing NPDES permit.
3. 10 BOD 10 TSS; chlorination to 200 colonies/100 milliliters	B. 10 BOD 15 TSS; chlorination to 200 colonies/100 milliliters	Provides all of the above beneficial uses with the possibility of allowing fish and wildlife propagation (warm-water fishery).
3a. Level 3 plus nitrification to 2.0 mg/l of ammonia nitrogen	C. Level B plus nitrification to 2.0 mg/l of ammonia nitrogen	Minimizes ammonia toxicity problems for fish and reduces nitrogenous oxygen demand. As fish and wildlife propogation is a beneficial use now mandated for the Canadian River, this level of treatment is ultimately required to meet existing beneficial use designations.
3b. Level 3 plus phosphorus removal	none	Would limit the growth of algae and thereby reduce the diurnal changes in dissolved oxygen swing in the river system caused by algal kinetics. No treatment alternative was designed for this level because dissolved oxygen deficits in the Canadian are caused by biochemical and nitrogenous oxygen demands rather than algal respiration (ACOG, 1981, p. 6-6).
4. 5 BOD 5 TSS; chlorination; 2 mg/l ammonia and nitrate nitrogen; 1 mg/l phosphorus	D. 5 BOD 10 TSS; chlorination; 2 mg/l ammonia nitrogen	This level meets all of the requirements of the existing stream standards, and in addition would reduce nutrient loading (especially phosphorus) which appears to be threatening Lake Eufala with eutrophication.

Sources: PSC, 1981; ACOG, 1981a; OSDH, 1980a.

represented by ACOG level 2 (facilities plan level A). ACOG's recommendation is based on the goal of achieving secondary treatment for all Canadian River discharges before progressing to higher treatment levels.

If the Canadian River remains designated as a warm-water fishery, then additional treatment would be required; this treatment is designated by ACOG treatment level 3a (facilities plan level C). It is also possible that additional treatment (phosphorus removal) would be required to reduce the potential for eutrophication of Lake Eufala. In that case ACOG treatment level 4 would be required. (Note that while the equivalent facilities plan level D does not mention phosphorus removal, it is provided by the alternatives recommended by the facilities plan.) Combinations of the wasteload allocations given in table 4-3 are also possible, but have not been specifically assessed in the facilities plan. This EIS analyzes the alternatives given in the facilities plan in the light of the four treatment levels specified in the table.

4.4 PURPOSE OF EIS

The Environmental Protection Agency (EPA) determined that an Environmental Impact Statement (EIS) was necessary regarding any proposed or alternative wastewater facilities considered for Norman. The EPA decision was announced in a Notice of Intent published in the Federal Register on June 29, 1978. The EIS has been prepared using the "piggybacking" approach whereby the impact evaluation was performed by Lee Wilson and Associates, Inc., of Santa Fe, New Mexico, parallel to preparation of the facilities plan.

This EIS is intended to provide essential information regarding the options available for treatment and reuse of wastewater so that citizens and government officials can make an informed choice among the available alternatives. In evaluating alternatives the technique of cost-effectiveness analysis is used. The analysis involves comparing all alternatives in a logical, objective, and systematic manner in order to identify relative merits and deficiencies. Where practical, the comparisons are quantitative, and in some cases they involve the use of monetary values. The goal of the analysis is to identify the most cost-effective alternative, which is the option that:

- achieves all requirements mandated by federal, state and local laws and regulations, including environmental requirements; and

- does so with the minimum long-term cost to society, that is, with the most benefits and lowest attainable combination of dollar expenditures, environmental sacrifices and social burdens.

While quantitative and monetary terms are used in the analysis, cost effectiveness is partly dependent upon qualitative considerations and subjective judgments. Consequently the results of the analysis are neither absolute nor fixed.

CHAPTER 5

DESCRIPTION AND EVALUATION OF ALTERNATIVES

5. DESCRIPTION AND EVALUATION OF ALTERNATIVES

This chapter describes and evaluates alternative plans for managing wastewater in the city of Norman. Alternatives considered by the city are presented in part A of the chapter. Alternatives available to the Environmental Protection Agency (including funding alternatives) are discussed in part B (see page 5-51). In all cases the evaluation focuses on key issues which bear on the selection of the 'best' (most cost-effective) alternative. Technical details on these issues are presented (as necessary) in chapter 6.

PART A. ALTERNATIVES CONSIDERED BY THE APPLICANT

With the assistance of the Citizen's Advisory Committee (CAC), the city evaluated a large number of alternatives for the collection and treatment of wastewater within the city limits. One general alternative, that of taking no action, is discussed in section 5.1. Section 5.2 considers alternatives for improvements to the collection system. Section 5.3 provides data on treatment alternatives and considers treatment processes, plant sites and potential wastewater reuse. Section 5.4 discusses alternatives for sludge treatment and disposal. Section 5.5 deals with the many other aspects of a wastewater management plan: on-site systems and septage disposal (5.5.1); disinfection alternatives (5.5.2); energy conservation (5.5.3); reduction of odors (5.5.4); water conservation (5.5.5); control of nonpoint-source pollution (5.5.6); administrative matters (5.5.7); and alternatives for funding the project (5.5.8). Section 5.6 summarizes the preliminary decisions which have been made by the city regarding the preferred alternatives.

5.1 NO ACTION ALTERNATIVE

General impacts. The No Action alternative would leave in place the existing wastewater management system of Norman, which is described in appendix A. As stated in chapter 4, the existing collection system and treatment plant cannot fully satisfy existing needs nor accommodate anticipated growth. Thus, if no action is taken, existing problems would continue. If growth occurs in the manner which has been projected by the city, the problems would become more serious.

Bishop Creek interceptor. Norman has already rejected the No Action alternative with respect to the major components of the Bishop Creek interceptor (see section 4.2). This decision was made to avoid the following adverse impacts, which would also occur in the event that the project is not completed.

1. Sewage overflows would expose area residents and visitors to potential health hazards; odors would infringe on enjoyment of outdoor activities.

2. The current moratorium on construction cannot keep the problem from becoming worse, since the Municipal Hospital expansion has been exempted from the moratorium, and users with existing hookups could increase their water usage with a corresponding increase in sewage flows.

3. Without relief sewers, the moratorium would be continued indefinitely, leading to land use patterns which conflict with city policies and the recently adopted COMPLAN. Specific patterns resulting from the moratorium would include: development of the service area at low densities with use of on-site systems (septic tanks), rather than at urban densities appropriate to a compact growth form; prohibition against infill on vacant lots, weakening the efforts to revitalize older neighborhoods; and the existing Woodcrest lift station emergency holding pond, utilizing 20 acres, would become a permanent land use in a residential area.

These changes would decrease the value of property within the Bishop Creek service area, while increasing property values elsewhere in Norman. Although the Little River basin could not be developed at urban densities, equivalent growth at lower densities would not be precluded; thus there is no assurance that a continued moratorium in the Bishop Creek basin would reduce the impact of storm runoff in the watershed.

Other parts of the collection system. Problems in the remainder of the collection system, such as Imhoff Creek, are similar to but less severe than Bishop Creek. Adoption of the No Action alternative in these areas would have consequences similar to those described above for Bishop Creek. In the older parts of Norman, where collection lines are inadequate, infill development would increase flows, leading to more frequent complaints of blockages and odors and the potential for serious health hazards from overflows. It is likely that a hookup moratorium would be adopted eventually, which would shift urbanization away from the urban core and into rural areas, including potential farmlands and the Little River basin.

Treatment plant. Because the treatment facilities have physical limitations which prevent compliance with existing and proposed NPDES permit requirements, selection of the No Action alternative would result in continued violation of effluent limitations. If growth is permitted, effluent quality would deteriorate further, causing deterioration of stream quality in the South Canadian River. In turn, this would adversely impact the value of the river as a habitat and recreational resource.

Sludge management. If the No Action alternative were implemented, any significant growth in the sewered population of Norman would cause existing sludge treatment units to be overloaded. Such overloading would almost certainly result in a highly objectionable odor problem, could establish conditions favorable for disease-causing organisms such as flies, and could interfere with treatment processes. In addition, the existing sludge disposal practice of land application by local farmers poses potential health risks due to handling and use of sludge as a fertilizer or soil amendment, and therefore does not conform to current or contemplated EPA regulations.

5.2 COLLECTION SYSTEM ALTERNATIVES

5.2.1 Service Area

Norman proposes to extend the service area of the municipal sewer system in conformance with policies set forth in the city's comprehensive plan (COMPLAN). As discussed in section 6.6.1, that plan is aimed at accommodating projected growth, providing services in a cost-effective manner, preserving agricultural lands, protecting the Lake Thunderbird drainage, and generally minimizing the adverse environmental impacts of growth.

The COMPLAN for the city has designated three growth areas, Tiers I, II, and III, and one non-urban area, Tier IV (see figure 5-1). These growth areas represent the stable urban area (Tier I), the urbanizing fringe (Tier II), and the urban reserve (Tier III). Tier IV has been set aside for preservation of rural and agricultural uses. It includes Lake Thunderbird, most of that lake's drainage area within the city limits, and the bulk of the city's prime agricultural lands.

To encourage phased growth, the city has adopted a policy of providing all facilities in Tier I at city expense. In Tier II the basic utility infrastructure system is to be provided, but hookups, interior streets, and similar services are to be paid for by the developer of the land. In Tier III growth is discouraged until the first two tiers build out, and developers must provide all infrastructure in a manner compatible with city plans.

Detailed population projections for the city (section 6.6.1) indicate that over the planning period urban growth will extend into previously unsewered basins in Tier III north and east of the existing urban core. Figure 5-2 illustrates the extent to which the wastewater collection system service area needs to be expanded in order to accommodate the projected growth. Not all of the land within the expanded service area would be developed by 2000. Due to the city's phased growth concept most population increase is expected to occur on the fringe of the developed area and a relatively small amount in the Tier III areas.

Virtually all of the newly served areas would be within the Little River basin. The major environmental issues associated with the proposed service area are the potential impacts of urbanization on agricultural land and the potential for pollution of Lake Thunderbird.

Preservation of agricultural lands. A major aim of EPA and city policies is to protect agricultural lands for reasons which include:

- the irreplaceable role of these lands in the production of food and fiber;

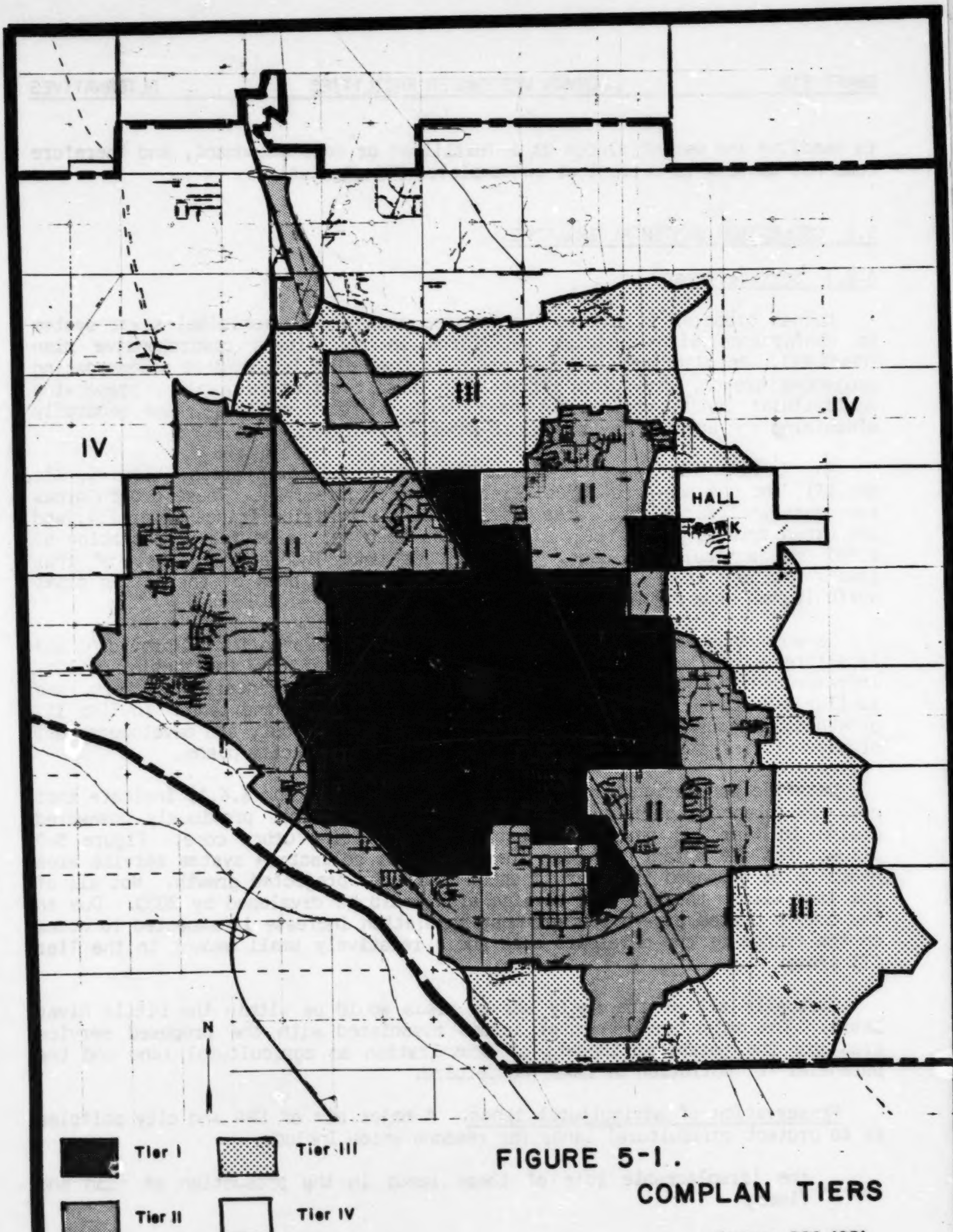

IV
III
IV
II
HALL
PARK
II
II
III
I
N
Tier I
Tier II
Tier III
Tier IV

FIGURE 5-1.
COMPLAN TIERS

Source: PSC, 1981.

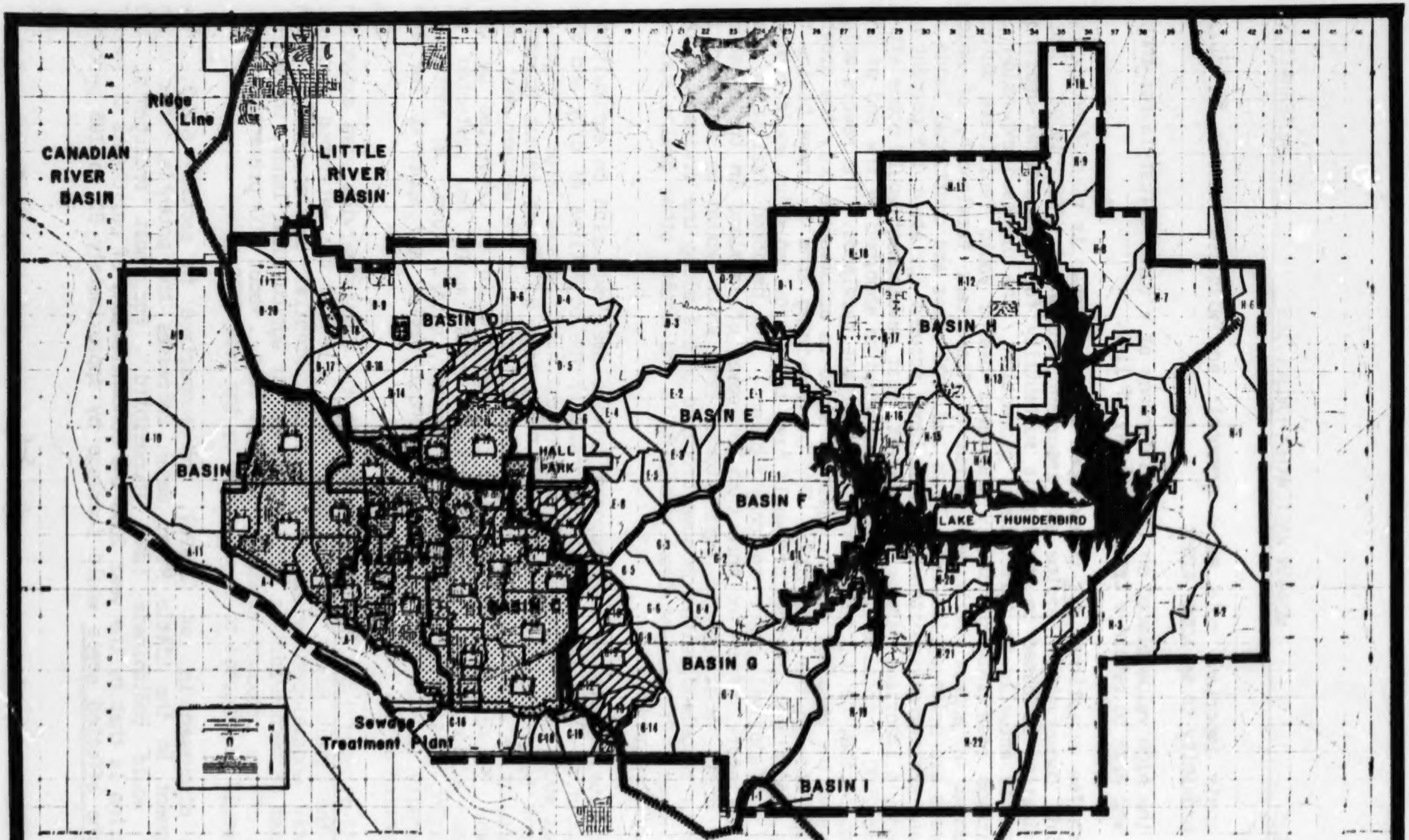

CANADIAN RIVER BASIN
Ridge Line
LITTLE RIVER BASIN
BASIN D
BASIN E
BASIN F
BASIN G
BASIN H
BASIN I
BASIN C
BASIN A
HALL PARK
LAKE THUNDERBIRD
Sewage Treatment Plant
Boundary of Drainage Basins
Existing Service Area
Proposed Service Area

FIGURE 5-2. EXISTING AND PROPOSED SERVICE AREA BASINS, YEAR 2000

Source: PSC, 1981.

- their important role as a greenbelt and wildlife habitat in close proximity to an urban area;

- the high value placed on the maintenance of a rural lifestyle for those who wish to retain a traditional way of life.

With few exceptions, all undeveloped land in Norman is classified by the U.S. Soil Conservation Service as "important farmlands" (SCS, 1979). This classification is based on the land's suitability for agricultural use; not all land is actually in agricultural production. The proposed expansion of the service area into previously unsewered basins would facilitate future development of approximately 4600 acres of "important farmlands", of which 1500 acres are prime agricultural lands and 3100 acres are additional lands of local and state-wide importance. These lands account for about 1.5 percent of the county's important farmlands. However, most development would occur after the year 2000; a total of about 600 acres would be absorbed by the end of the planning period, or 0.2 percent of the important farmlands. The sewers which would serve the expanded service area are sized to accommodate only the growth projected through the year 2000. For the remaining land in these basins to develop, additional interceptors would have to be provided which would require review and approval prior to construction. The proposed facilities plan would, therefore, affect no more than 600 acres of farmland in the expanded service area. Most of the agricultural land which would be impacted is pasture or rangeland, although some cropland occurs along the drainage of the Little River. Predominant crops are alfalfa and wheat; other grains such as corn are also grown.

Negative impacts of the proposed service area expansion on agricultural land would be minor for several reasons. 1) The objectives of city and EPA policies would still be met within the project area, because large acreages of important farmlands would remain. 2) The action would not impact Norman's most productive agricultural lands, which are located in the western-most part of town. 3) Although some agricultural lands would be converted by the proposed action, remaining agricultural areas would be protected by encouraging urbanization to occur in a compact, orderly form. 4) Additional high-density growth could not occur without review and approval for the construction of new interceptors.

Pollution of Lake Thunderbird. Almost the entire service area expansion is in the Little River basin. Nearly 4700 acres of the watershed that are currently undeveloped would be opened to potential development at urban densities (8 people/acre or more). But, as for agricultural lands, the actual impact of the proposed expansion is much less. About 600 presently vacant acres would be expected to be developed by the year 2000.

As discussed in LWA (1982a), and summarized in section 6.6.3, this development in the Little River Basin increases the potential that urban runoff would contaminate Lake Thunderbird. For most pollutants, the projection is that by the year 2000 the concentrations of pollutants in runoff from the affected acres would increase by approximately 85 to 285 percent, depending on the pollutant. However, because the total acreage is small, the net impact on Lake Thunderbird would be small. The magnitude of change in the water quality of Lake Thunderbird can be illustrated by looking at phosphorus loadings, which would increase by approximately 2200 pounds per year, or 3 percent above present loadings (see section 6.6.3).

Other factors would also be expected to impact the quality of the lake, as illustrated by the following examples (see details in section 6.6.3).

1. Residential and industrial development in the existing service area would add up to 2500 pounds of phosphorus annually by the year 2000, or 3 percent above present loadings.

2. Residential development in the rural parts of Norman, outside the proposed service area, could add 2950 pounds of phosphorus annually by the year 2000, or 4 percent above present loadings.

3. Growth which would occur outside of Norman would increase pollutant loadings. In Moore alone, growth would add 19,300 pounds of phosphorus annually by the year 2000, or 25 percent above present loadings.

4. In addition, there would be other residential, industrial, public and commercial development scattered throughout the area. Altogether, ACOG projections for the basin indicate that there will be nearly 12,000 acres developed in the basin between 1977 and the year 2000, bringing the total developed acreage to 20,560. Increased phosphorus loadings would be on the order of 42,000 pounds per year by the year 2000, more than a 50 percent increase over current loadings.

5. Additional development past the year 2000 would further increase the potential for pollutants to reach the reservoir. For example, if the entire acreage within the expanded service area were someday developed (through construction of additional interceptors beyond those proposed in the facilities plan), phosphorus loadings would be further increased by up to 19 percent when compared to current conditions, bringing the total impact of the proposed sewered area to 22 percent.

In total, the phosphorus loadings to Lake Thunderbird could more than double as the result of the anticipated growth in the watershed, facilitated by the extension of sewer lines into the Little River basin. Similar conclusions can be reached for other pollutants.

This is a worst case estimate and does not account for the potential mitigation from upstream ponds. Moreover, as discussed in section 6.2, it is not certain that the increase would result in any major change in the chemistry or biology of the reservoir. For example, the high sediment load in the lake could fully compensate for the increased pollutant loading by: a) absorbing many of the contaminants; and b) reducing the availability of light which is a prerequisite to nuisance algal blooms. On the other hand, the state-of-the-art in predicting land-use/water-quality relationships is not sufficient to be sure that this increased loading would not cross a significant threshold, and lead to major and even irreversible changes in the reservoir. The conclusion, then, is that there is a potential for adverse impacts on Lake Thunderbird from land conversion, but that harm is not certain. The growth facilitated by the expanded service area accounts for only a portion of the impact; in combination with other projected growth it could be a cause for concern. This conclusion suggests that detailed studies of the watershed/reservoir ecosystem are needed and that, as an interim measure, it may be appropriate to consider measures to mitigate the potential increases in pollutant loadings from urbanizing lands. Such measures are discussed briefly in section 5.5.6.

Alternatives. The projected growth pattern is designed to balance and minimize the potentially adverse effects of growth. Alternatives to the proposed service area could have more significant adverse impacts on the community as a whole. For example, the most realistic alternative would be to attempt to shift the growth to the west of town in the South Canadian basin. However, this area contains Norman's most productive farms which would be lost as land was converted for urban use.

With the population increases projected for the region, it appears inevitable that some development will occur in the Little River basin. The development pattern proposed by the COMPLAN is compact and provides a controlled approach towards accommodating Norman's projected growth. The alternative of providing no sewer service would not preclude development in the basin, but rather would lead to a different form of growth, involving low-density rural subdivisions. Even if Norman could prohibit all development in its portion of the Little River Basin, growth in Moore and Hall Park would continue to impact the reservoir. Thus, the realistic alternatives relate to the analysis and control of potential nonpoint-source pollution problems, rather than to a no-growth policy on the part of the city. Such controls are discussed briefly in section 5.5.6.

The alternative also exists to establish a larger service area than now proposed. Such an expanded service area would encompass some or all of the large part of Norman which is designated for rural development, and would not be consistent with the COMPLAN. Without sewer service, these rural areas would continue to dispose of liquid wastes through on-site systems, such as septic tanks. No major sanitation or ground water problems are known to exist from the use of such systems and problems are not expected to occur in the future provided that on-site systems are used on relatively large lots, and that designs conform to criteria specified by the Oklahoma State Department of Health. Thus, there is no environmental or public health objective which suggests the COMPLAN should not be followed.

Summary. Norman proposes to extend the service area of the municipal sewer system in conformance with policies set forth in the COMPLAN. Among other consequences, this would provide service to presently unsewered portions of the Little River basin north and east of the existing urban core. Although some 4,600 acres of land would be opened to high-density development, the sewer lines which are actually proposed (see section 5.2.2) would be sized to allow development of only 600 acres. Most of the affected land is considered to be important farmland. The loss of this acreage is considered a minor impact because it is only 0.2 percent of the important farmlands within the city; by promoting a compact urban area, the proposed service area would help alleviate development pressures on other farmlands.

Urbanization of the Little River basin would increase the potential that urban runoff would contaminate Lake Thunderbird. This potential is also increased through growth of other cities within the basin and from development of rural subdivisions. Collectively, pollutant loadings into the reservoir could increase by more than 50 percent by the year 2000. It is not known if such an increase in loadings would adversely affect the lake. The presence of sediment could adsorb many of the pollutants and inhibit algal blooms; alternately, an ecological threshold could be crossed and the lake could experience algal blooms or other problems. Additional research at the national and local level will be needed to resolve this uncertainty. In the meantime, the magnitude of the potential increase in pollutant loadings appears large enough to warrant drainage control measures of the type recently imposed by Norman's drainage ordinance.

5.2.2 Sewerage System Alternatives

Appendix A discusses the existing sewerage system, which consists of: collection lines, collecting from individual houses with lines generally eight inches in diameter or less; interceptors, linking collection lines to the treatment plant with lines of ten inches in diameter or larger; and lift stations, required where slope is insufficient to continue gravity flow or where a ridge line must be crossed.

The Norman area is divided into natural drainage basins and sub-basins (figure 5-1). Most of the sewerage urban area is in basins A, B and C which are within the Canadian River basin; flow is primarily by gravity to the sewage treatment plant, which is south of the city. Additional sewered areas occur in basin D, which is in the Little River basin; the Little River basin is separated from the Canadian basin by a broad ridgeline trending northwest to southeast. All sewage collected in the Little River basin must be pumped into the Canadian basin, since discharge of wastewater within the Little River basin is prohibited by regulation of the Central Oklahoma Master Conservancy District (COMCD).

The existing system is now or will become overloaded in several locations, especially in sewerage basins B and C, even without substantial population growth (see sections 4.2 and 5.1). There is no realistic alternative to solving the problems of the existing system; and, apart from a no-growth policy, there is no alternative to expanding the system so that it can accommodate orderly urban development.

Thus, the major sewerage system alternatives relate to decisions such as the location of new sewer lines, especially large interceptors, and the capacity of these new lines. Even here, however, the actual range of alternatives is limited, since basic decisions about expansion of the sewerage system are already contained in the city COMPLAN. Basically, lines need to be located in areas which the COMPLAN has designated for growth; and they must be sized to accommodate the growth which has been projected through the year 2000. A sewerage system which conforms to the COMPLAN must be considered as meeting the goals of the plan, which include providing services in a cost-effective manner, preserving agricultural lands, protecting the Lake Thunderbird drainage, and generally minimizing the adverse environmental impacts of growth.

In summary, in establishing the basic framework for the growth of Norman, the COMPLAN both prescribes the character of the future sewerage system and establishes that the environmental effects of the system are those which the community deems acceptable.

The major environmental concern not resolved by the COMPLAN is the need to select specific routes, and/or to develop specific construction methods which will minimize: the effects of construction noise, dust and equipment emissions; disruption of traffic, utility service, business activities and other community services; potential impacts to the natural environment (e.g. sensitive soils, habitats); removal and replacement of pavement; and routing of lines through areas where development may not be appropriate (e.g. farmlands).

The discussion which follows summarizes the specific proposals for expansion of the sewerage system which are contained in the facilities plan. Environmental factors which apply to a specific proposal are included in the discussions below. General impacts of facility construction are discussed in section 5.2.3, along with prospective mitigation measures.

Correction of infiltration/inflow problems. The existing sewerage system was analyzed in detail for infiltration and inflow as part of the facilities plan (PSC, 1979). The Infiltration/Inflow (I/I) report found that in the older, central part of Norman much of the sewer system is overloaded due to the existence of lines of inadequate size and slope. Infiltration, as from ground water, was found not to be a problem. Inflow, from major precipitation events, was found to be significant but not in excess of the standards of the Clean Water Act.

Collection lines. Due to the recurrent nature of blockages and overflows of collection lines in central Norman, replacement of 123,500 feet of collection line is recommended in the facilities plan. As these repairs (estimated in 1978 at $4.4 million) are not eligible for federal funding under the Clean Water Act, the costs are not included in estimates for the proposed action. Repairs are expected to be made only as local funds become available.

New collection lines are proposed for three areas on the south side of Norman, within the existing service area, that presently utilize on-site wastewater systems (figure 5-3). Nuisance-type complaints concerning those

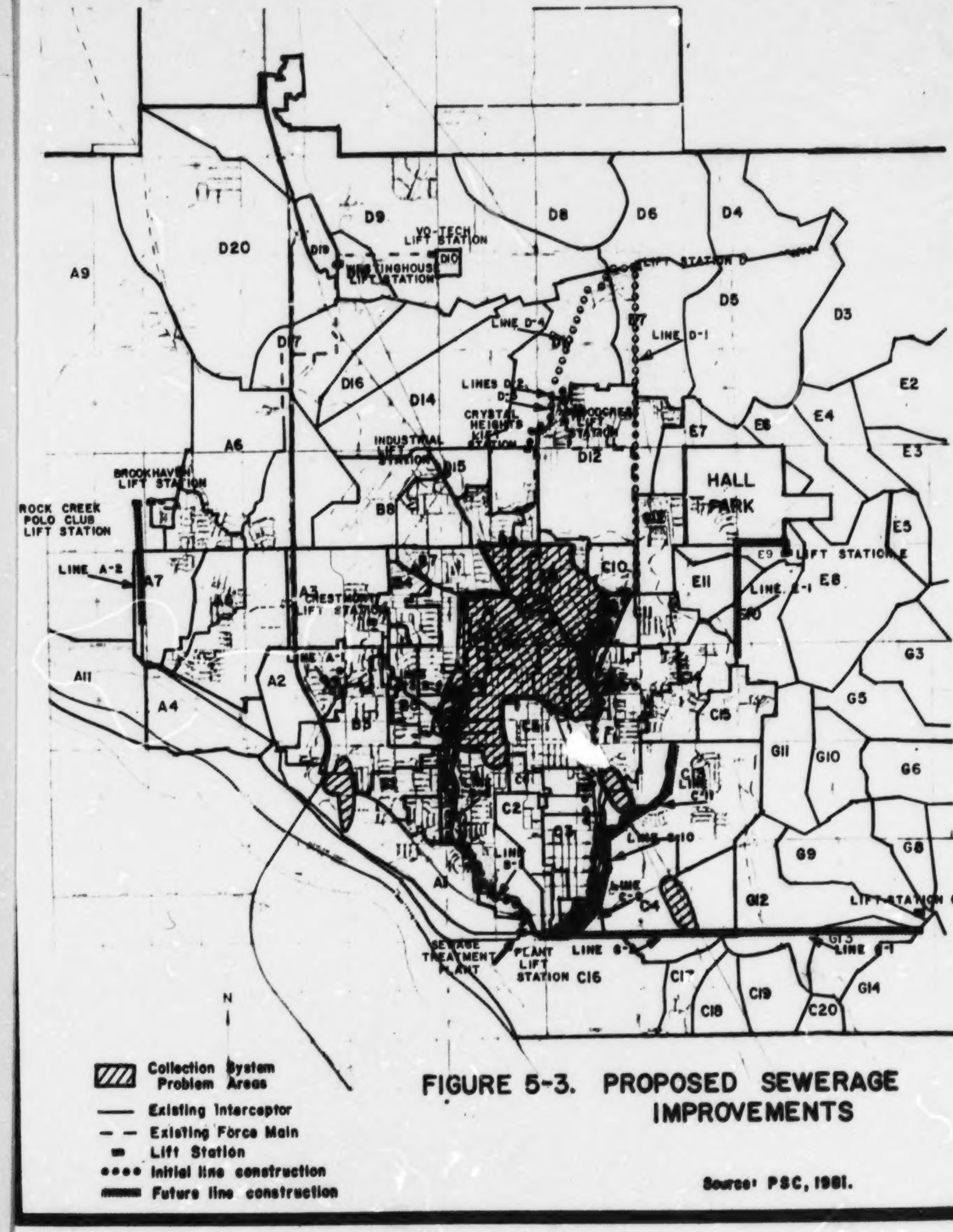

D9
D8
D6
D4
D20
A9
VO-TECH LIFT STATION
D19
D10
WESTINGHOUSE LIFT STATION
LIFT STATION D
D5
D3
D7
LINE D-4
LINE D-1
D17
D16
D14
LINES D-2, D-3
CRYSTAL HEIGHTS LIFT STATION
LIFT STATION
E2
E4
E6
E7
E3
A6
INDUSTRIAL LIFT STATION
D15
D12
HALL PARK
BROOKHAVEN LIFT STATION
ROCK CREEK POLO CLUB LIFT STATION
B8
E5
LIFT STATION E
E9
LINE A-2
A7
A3
CHESTMONT LIFT STATION
C10
E11
E8
LINE E-1
E10
G3
A11
LINE A-1
A2
A4
B3
C15
G5
G11
G10
G6
C2
C3
LINE C-10
G9
G8
LINE B-1
A1
LINE C-9
C4
G12
LIFT STATION G
SEWAGE TREATMENT PLANT
PLANT LIFT STATION
C16
LINE G-2
G13
LINE G-1
C17
C18
C19
C20
G14
N
Collection System Problem Areas
Existing Interceptor
Existing Force Main
Lift Station
Initial line construction
Future line construction

FIGURE 5-3. PROPOSED SEWERAGE IMPROVEMENTS

Source: PSC, 1981.

areas have been received by the Norman Public Works Department (Baxter, 1982). For example, wastewater from on-site systems has repeatedly flowed onto the Santa Fe Railway right-of-way and into local canals. The three problem areas and required lengths of line are as follows.

1. West side of Classen Boulevard (Highway 77) north of Constitution; 2500 linear feet.
2. West side of Classen south of Highway 9; 2800 linear feet.
3. Along Southwest 24th Avenue from the South Canadian River to north of Highway 9 and along Fritzland Road; 4950 linear feet.

Total cost for the proposed 8-inch lines at $30 per linear foot is $307,500. Installation of these lines would eliminate potential health problems created by the surfacing of untreated sewage. These lines would be ineligible for federal funding until justification for funding of collection systems is provided in accordance with EPA regulations.

Interceptors. Overloading is occurring or anticipated to occur in existing urban areas in the Bishop Creek area and along the Imhoff Creek area. New development is expected to the north and east of Norman. These conditions require the construction of additional interceptor capacity. The facilities plan has used the year 2000 for design of all wastewater transportation facilities; thus line sizes are determined by the population projections adopted as part of the plan (see section 6.6.1).

Right-of-way is the major consideration in defining interceptor alternatives. Impacts such as traffic and utilities disruption are minimized where rights-of-way pass through undeveloped land. On the other hand, use of existing rights-of-way may save purchase (or condemnation) costs, and may be less disruptive. In town, flood plains often satisfy both requirements, since they provide an undeveloped right-of-way which passes through developed areas, and can be used for construction with minimal disruption of existing development patterns. However, the construction of sewer lines in flood plains can have potential adverse effects, especially increased potential for erosion. As discussed in section 6.1.3, such impacts are not expected to be significant in Norman, provided that mitigation measures are undertaken during project design and construction.

The major alternatives to the proposed alignments are to use existing street rights-of-way in the area. While these alternatives would avoid construction in the flood hazard areas, they would require extensive excavation of streets, with attendent impacts of noise, traffic and business disruption and possible interruption of utilities. These alternatives would also result in a major increase in project costs due to the removal and replacement of street surfacing, and the greater excavation needed to obtain the necessary wastewater flow gradients.

To accommodate existing and projected overloading, three major categories of interceptor alternatives were considered.

1. Parallel existing interceptors with new ones; this approach uses existing rights-of-way and is generally feasible when construction impacts would be minimal.

2. Rework the system to divert excess flows into an interceptor which has adequate capacity; this tends to be a comparatively inexpensive choice in those few cases where an overloaded line is close to one with excess capacity.

3. Build new interceptors from developed and developing areas to the treatment plant. This approach is most effective when it allows selection of a right-of-way along a flood plain or outside already developed areas; in these cases the significance of construction impacts is lessened.

All three concepts are proposed in various parts of the Norman interceptor system. A factor in the selection process was the need to minimize construction impacts by utilizing existing rights-of-way and open spaces. By routing interceptors in flood plains or along as yet undeveloped roadways, it is possible to minimize utility relocations, traffic disruption, access limitations, and impacts of construction noise and dust. However, careful construction planning is necessary to avoid erosion and other impacts (see section 5.2.3).

Figure 5-3 gives the location of proposed interceptors; table 5-1 summarizes costs of the lines. The proposed interceptors are labeled A, B, C, etc. to correspond to the designations of the wastewater basins they serve. Most work is proposed in basins B, C and D, to relieve existing overloading and to accommodate projected growth in the central and northeast portion of the service area. Total cost of the proposed sewerage system improvements is $9,802,000, of which $6,809,000 is considered eligible for federal funding participation according to the facilities plan. It should be emphasized that final determinations of eligibility will be made by EPA. The lines considered eligible by the facilities plan engineer may or may not be eligible for EPA participation under current requirements.

The proposed interceptors are discussed below, along with an evaluation of possible environmental impacts. Increases in phosphorus loadings are given as an example of impacts on Lake Thunderbird. General construction impacts and mitigation measures are summarized in section 5.2.3. Portions of the interceptors may be constructed in flood plains, depending on alignments as determined during the detailed design phase of the project. Again, refer to section 5.2.3 for a summary of impacts.

Basin A, Normandy Creek. A portion of the existing interceptor system along Normandy Creek, near Southwest 24th Avenue at Boyd Street, has structural problems resulting in surcharging (backing-up) of flows. To

TABLE 5-1. COST OF PROPOSED COLLECTION SYSTEM.

Basin Location of Line or Lift Station(LS)	Pipe Diameter	Length (feet)	Cost/ Foot	Construction Cost	Operation & Maintenance 7¢/foot/yr	Land Cost $10/foot
Initial Construction						
A-1	12"	1,025	36.25	57,656	71.75	10,250
B-1	30"	11,200	136.35	1,527,120	784.00	112,000
B-2	21"	2,700	94.50	255,150	189.00	27,000
B-3	21"	1,400	94.50	132,300	98.00	14,000
B-4	21"	1,500	94.50	141,750	105.00	15,000
C-1	33"	10,586	113.87	1,205,385a/	741.02	105,860
C-2	30"	6,500	136.35	886,275	45.50	65,000
C-3	24"	3,420	98.30	336,186	239.40	34,200
C-4	21"	2,300	94.50	217,350	161.00	23,000
C-5	12"	700	56.25	39,375	49.00	7,000
C-6	18"	6,600	70.28	463,848	462.00	66,000
C-7	10"	70	45.00	3,150	4.90	700
C-8	10"	2,540	45.00	114,300	177.80	25,400
LS-D	1480 GPM	1 L.S.		200,000	14,075.00	20,000
D-1	16" FM	12,000	40.00	480,000	840.00	120,000
D-2	10"	4,900	45.00	220,500	343.00	49,000
D-3	15"	2,800	67.50	189,000	196.00	28,000
D-4	18"	7,400	70.28	520,072	518.00	74,000
		77,641		$6,989,417	$19,100.37b/	$796,410b/
Construction Cost						
Eligible				5,659,208		
Ineligible (C-3 through C-8 and 3,900 l.f. of D-1)				1,330,209		
Total				$6,989,417		
Contingency						
Eligible				570,000		
Ineligible				130,000		
Total				$ 700,000		
Engineering Testing & Inspection						
Eligible				580,000		
Ineligible				260,000		
Total				$ 940,000		
Legal & Administrative (ineligible)				$ 280,000		
Total Present Worth						
Eligible				6,809,208		
Ineligible				2,993,196		
Total				$9,802,404c/		
Future Construction (Ineligible)						
A-2	15"	7,000	67.50	472,500	490.00	70,000
C-9	24"	3,700	98.30	363,710	259.00	37,000
C-10	24"	8,000	98.30	786,400	560.00	80,000
C-11	21"	3,800	94.50	359,100	266.00	38,000
LS-E	250 GPM	1 L.S.		50,000	5,397.00	10,000
E-1	8" FM	10,300	20.00	206,000	721.00	103,000
LS-G	676 GPM	1 L.S.		100,000	7,430.00	10,000
G-1	10" FM	10,000	25.00	250,000	700.00	100,000
G-2	15" FM	6,000	67.50	405,000	420.00	60,000
		$50,800		$2,992,710	$16,243.00	$508,000
Construction Cost				2,992,710		
Contingency				300,000		
Engineering, Testing & Inspection				360,000		
Legal and Administrative				120,000		
Total Present Worth				$4,447,882		

a. Completed.
b. Ineligible for federal funding.
c. Includes operations and maintenance and land costs. Total Present Worth of initial construction operations and maintenance is $196,577; $167,172 for future.

Source: PSC, 1981.

correct this problem, the facilities plan proposes that an existing twelve-inch segment of the line be relocated to the west bank of Normandy Creek (figure 5-3). Table 5-1 provides some details on the proposal; refer to the facilities plan for additional information. The proposed action would facilitate urbanization of 175 acres of agricultural land in sub-basin A-2. This represents 0.05 percent of the important farmlands in the county and is in conformance with the COMPLAN. There are no major streets in the area of proposed construction; thus, construction impacts would not include traffic or utility disruption.

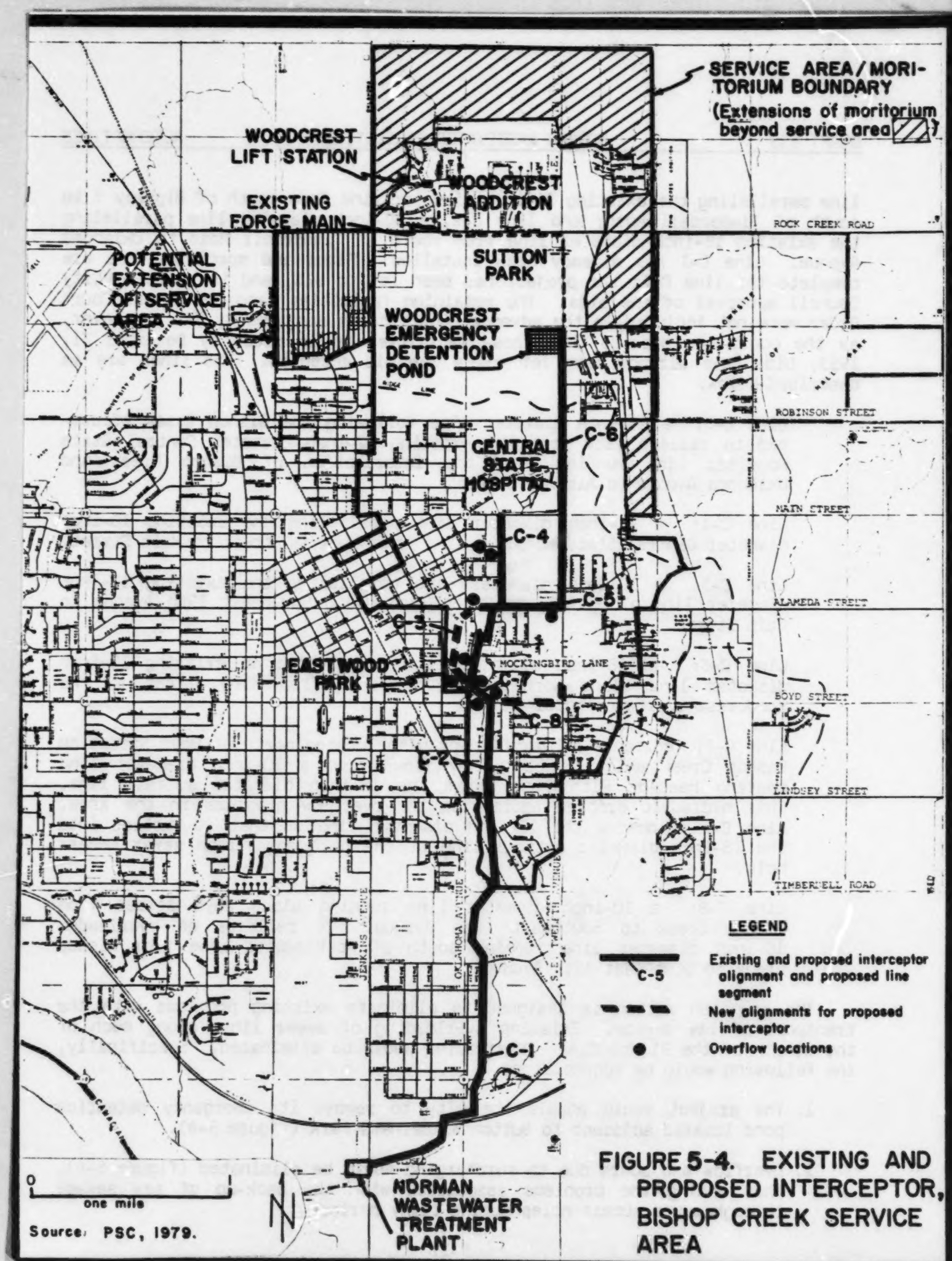
The facilities plan also recommends that, when sufficient population exists, a fifteen inch interceptor (line A-2) be installed from the Rock Creek Polo Club lift station to a point about three quarters of a mile south of Robinson Street. This would eliminate the need for both the Rock Creek and Normandy lift stations.

Basin B, Imhoff Creek. Construction in this basin would serve to correct existing deficiencies and to provide for anticipated growth within the service area. The current problem involves surcharges (back-ups) in the existing 24-inch interceptor, caused by a flow constriction at the treatment plant. A temporary diversion box has been constructed to alleviate the problem at the plant. However, this line also has insufficient capacity to handle the projected year 2000 flows. The facilities plan recommends that the existing 24-inch line be paralleled by 11,200 feet of 30-inch line. The new line would accommodate growth, but would not eliminate the need to use a screw pump to lift the wastewater into the treatment plant. The route would generally follow the existing right-of-way, which is in a developed area; however it would not pass through subdivisions and beneath houses as does the existing interceptor.

The proposed Imhoff Creek improvements include an additional 5600 feet of 21-inch interceptor running north from the 30-inch line. This line would eliminate several existing interceptors which are in poor condition, and provide the capacity needed for the year 2000. The route would diverge from existing routes and would generally lie in the floodplain of Imhoff Creek, thereby avoiding developed residential areas. As discussed on p. 5-12, construction in the floodplain poses potential adverse impacts such as erosion; alternative routes, however, would be more expensive and more disruptive of traffic during construction.

The line would facilitate development of 175 acres of significant agricultural lands, less than 0.1 percent of such lands in the county. Part of this land is in the Little River basin, proposed for industrial development. This development would increase phosphorus loadings to Lake Thunderbird by 600 pounds per year, an increase of 0.7 percent.

Basin C, Bishop Creek. As discussed in section 4.2, Norman has undertaken advance construction of relief interceptor sewers in the Bishop Creek area (figure 5-4). The two segments nearest the treatment plant were approved for advance construction by EPA. These lines are: line C-1, a 33-inch diameter


SERVICE AREA/MORITORIUM BOUNDARY
(Extensions of moritorium beyond service area ▨)
WOODCREST LIFT STATION
WOODCREST ADDITION
EXISTING FORCE MAIN
ROCK CREEK ROAD
POTENTIAL EXTENSION OF SERVICE AREA
SUTTON PARK
WOODCREST EMERGENCY DETENTION POND
ROBINSON STREET
C-6
CENTRAL STATE HOSPITAL
MAIN STREET
C-4
C-5
ALAMEDA STREET
C-3
EASTWOOD PARK
MOCKINGBIRD LANE
C-7
BOYD STREET
C-8
C-2
UNIVERSITY OF OKLAHOMA
LINDSEY STREET
JENKINS AVENUE
OKLAHOMA AVENUE
S.E. TWELFTH AVENUE
TIMBERDELL ROAD
LEGEND
Existing and proposed interceptor alignment and proposed line segment
C-5
New alignments for proposed interceptor
● Overflow locations
C-1
0
one mile
NORMAN WASTEWATER TREATMENT PLANT

Source: PSC, 1979.

FIGURE 5-4. EXISTING AND PROPOSED INTERCEPTOR, BISHOP CREEK SERVICE AREA

line paralleling the existing 21-inch diameter line from south of Highway 9 to south of Timberdell Road; and line C-2, a 30-inch diameter line paralleling the existing 18-inch diameter line from south of Timberdell Road to Oklahoma Avenue. Line C-1 has already been installed. Plans and specifications are complete for line C-2; the project has been let to bid, and is awaiting City Council approval of the bids. The remaining facilities mandated by the Court Order were not included in the advance construction approved by EPA. However, as the court has ordered that these facilities be in place by December 31, 1983, bids have already been let and a low bid accepted. The lines are as described below.

> Line C-3: a 24-inch diameter line following the Bishop Creek streambed to relieve flow from the existing 12-inch diameter Central State Hospital line running from the intersection of Bishop Creek and Oklahoma Avenue to Alameda Street.
>
> Line C-4: a 21-inch diameter line paralleling the existing 10-inch diameter Central State Hospital line from Alameda Street to Main Street.
>
> Line C-5: a 12-inch diameter line paralleling the existing 12-inch diameter line along Alameda Street and along Southeast 12th Avenue to Main Street.
>
> Line C-6: an 18-inch diameter line paralleling an existing 10-inch diameter line along Northeast 12th Avenue from Main Street to the Woodcrest emergency holding pond.
>
> Line C-7: corrects a hydraulic problem located north of Boyd Street on Bishop Creek which is caused by flows from a 10-inch diameter line meeting head-on with flows from the 18-inch diameter outfall line. This hydraulic problem aggravates the overflow problems in the area. Line C-7 relocates the 10-inch diameter line so that it empties into the 18-inch diameter outfall line at the next downstream sewer access hole.
>
> Line C-8: a 10-inch diameter line running along Boyd Street from Bishop Creek to Southeast 12th Avenue. It relieves an overloaded 10-inch diameter line running south of Mockingbird Lane from Bishop Creek to Southeast 12th Avenue.

The proposed action is designed to eliminate existing problems with the transport of raw sewage. Existing overloading of sewer lines along much of the length of the Bishop Creek interceptor would be eliminated. Specifically, the following would be accomplished.

1. The project would enable the city to remove its emergency detention pond located adjacent to Sutton Wilderness Park (figure 5-4).
2. Overflow and odors due to surcharging would be eliminated (figure 5-4), thus ending the problems associated with the back-up of raw sewage through sewer access holes during rainy periods.

3. The moratorium on development in the area would be ended as the various segments of the project were completed.

4. The city would fulfill its obligations under U.S. District Court action No. CIV-79-683-E for timely provision of adequate sewer services to the Bishop Creek moratorium area, timely being defined in the court action as December 31, 1983 for completion of all construction.

5. Basic wastewater facilities would be available to assist in the orderly development of Norman according to the proposed Comprehensive Plan (COMPLAN).

An alternative to the proposed action would be to construct larger relief lines sufficient to carry the ultimate projected flows from the service area and from areas beyond which may someday be served by the municipal collection system. This alternative was not considered to be appropriate because it would conflict with city policy to limit facilities to the size needed to accommodate growth through the year 2000, rather than sizing them to accommodate less certain expectations of growth beyond this period. Also, such an action would, in effect, make a commitment to extensive development in the Little River basin, with possible adverse environmental effects.

Alternatives to alignments of the various segments, and impacts and mitigation measures, were evaluated in the Bishop Creek Environmental Information Document (LWA, 1980), prepared as part of the requirements for EPA approval for advanced construction of the Bishop Creek lines.

Adverse impacts of the improvements along Bishop Creek are generally limited to those related to construction, as summarized in section 5.2.3. As the Bishop Creek service area is already largely developed, conversion of agricultural land through residential development would be small -- about 156 acres. Impacts on phosphorus loadings to Lake Thunderbird would be an increase of up to 80 pounds per year, 0.1 percent over current loadings.

Basin D, unnamed tributary of the Little River. Construction in this basin would serve to correct existing deficiencies and to provide for anticipated growth within the service area. The current problem involves the need to eliminate the temporary emergency holding pond which stores the flows from the Woodcrest lift station; this pond is located on 12th Avenue (figure 5-4). The present site of the Woodcrest lift station, in the midst of a residential development, does not allow for construction of a replacement emergency holding pond. Therefore, the facilities plan has proposed to relocate the Woodcrest lift station to a point 1.5 miles north of the present site (lift station D on figure 5-3). This location was selected as the best in terms of the ultimate development of basin D; that is, the site assumes that the basin will continue to urbanize past the year 2000.

The proposed action would allow elimination of the existing Woodcrest lift station and emergency pond. It would also allow elimination of the Crystal Heights lift station. As the Crystal Heights lift station presently pumps wastewater into the overloaded Imhoff Creek interceptor system, the proposed action would serve to reduce stress on that system. Line D-2 (figure 5-3) would serve to collect wastewater from the Crystal Heights area. Line D-3 would carry existing and projected flows from the Woodcrest area. Line D-4 would collect wastewater from lines D-2 and D-3 and deliver it by gravity to the relocated Woodcrest lift station. These lines would generally follow the alignment of an unnamed tributary of the Little River.

The new lift station D would be sized to handle growth projected for the service area through the year 2000 but, as noted, the location would be suitable should development continue past that time. This situation gives rise to a potential problem, because it is not entirely consistent with the COMPLAN. The presumption of the COMPLAN and facilities plan is that, through the year 2000, most growth in basin D would occur close to the existing urban area, in Tier II. Interceptors from this area would be sized to accommodate that growth (a total population increase of 4000 persons), and would run north to the new lift station and then south to connect with the Bishop Creek line through basically undeveloped basins D-7 and D-11. Basins D-7 and D-11 are in Tier III and are projected to receive an additional 500 people by the year 2000 who would also be served by the interceptor.

However, nothing in the design of the system would force the preferred development pattern. Rather, much or all of the growth of 4500 persons could occur in leapfrog fashion, in basins D-7 and D-11, rather than adjacent to the urban area as proposed by the COMPLAN. To discourage growth in Tier III until Tier II is developed, a hookup policy would probably be needed. The lack of other utility infrastructure would also discourage developers but, in itself, may not be enough to effectively slow growth in sub-basins D-7 and D-11. Unless controlled, such growth could contribute to sprawl, increase the impact on agricultural lands in the proposed service area, and increase the cost of providing public services such as police and fire. Further, since most utility infrastructure is provided through subdivision, scattered growth would result in gaps in the infrastructure system.

An alternative site for relocation of the Woodcrest lift station would be to place it at the intersection of lines D-2 and D-3. This would accommodate growth through the year 2000, but not beyond; the station would need to be relocated (or a new station constructed) if basins D-7 and D-11 continue to grow past the year 2000. The costs of this alternative have not been evaluated in the facilities plan, but would be less than the proposed location because the alternative relocation would eliminate the need for line D-4 (at least until basins D-7 and D-11 developed). Construction impacts could be greater than for the proposed site, because no access exists to the alternative location, and a road would have to be installed.

The alternative location is in agreement with the COMPLAN in that the city would not be providing infrastructure to a currently undeveloped Tier III area. The Citizen's Advisory Committee has endorsed the alternative lift station location.

Interceptor system D would allow the urbanization of nearly 460 acres of agricultural land, including land in both the existing and proposed service areas. This represents 0.14 percent of the significant agricultural lands in the county and does not conflict with the COMPLAN. This development would also increase phosphorus loadings to Lake Thunderbird by up to 1600 pounds per year, an increase of 2 percent.

Basin E, Rock Creek. A new interceptor is proposed to serve projected urban growth in basin E. The line would commence with lift station E, which would consolidate small lift stations likely to be built to serve individual subdivisions. From lift station E, wastewater would be pumped over the ridge line to the Canadian River basin and delivered to a part of the Bishop Creek interceptor system. The alignment of line E would be in largely undeveloped street rights-of-way. Line E would allow urbanization of 148 acres of significant agricultural land. This development would also contribute about 500 pounds of phosphorus per year in the runoff to Lake Thunderbird, an increase of 0.6 percent.

As a result of development in basin E, additional capacity would be required for that part of the Bishop Creek interceptor system receiving basin E flows. The facilities plan proposes constructing parallel lines (C-9, C-10, C-11) from the treatment plant to Lindsey Street. Because of low slope grade, the lines would be larger than required for year 2000 populations (in order to minimize friction, and allow conveyance of flows without creating septic conditions). Unless hookups to this line are prohibited, it would allow (and could encourage) growth in the Bishop Creek area at rates faster those projected in the COMPLAN. This growth would occur in Tier II in an area projected for residential use, and thus would not violate the basic precepts of the COMPLAN. Construction of the parallel lines in basin C would not be necessary unless and until development occurs in basin E as projected.

Basin G, Dave Blue Creek. A new interceptor is proposed to serve projected development in Dave Blue Creek. Lift station G would pump wastewater out of this basin into the Canadian River basin, where line G would deliver it directly to the treatment plant. Line G would allow urbanization of 399 acres of significant agricultural land. The conversion of this land to residential use would also increase phosphorus loadings to Lake Thunderbird by nearly 500 pounds per year, an increase of 0.6 percent.

Lines E and G are proposed for construction at an as-yet-undetermined time, depending on the rate of development. If the COMPLAN is followed, construction would not occur until land closer in is developed. Initially, subdivisions in basins E and G would be served by separate lift stations and force mains built by the developers. The city would eventually build the proposed facilities to consolidate the individual stations and lines.

Impacts of line sizing. All interceptors are proposed to be sized to accommodate growth projected through the year 2000. No excess capacity is planned, and calculations by the facilities plan engineer indicate little reserve capacity in most lines. This action is designed to support orderly, compact growth which would be concentrated in Tier II areas of Norman. Also, the commitment to develop in the Little River watershed would be limited to that growth which is forecast through the year 2000. While this approach has positive effects in terms of implementing the COMPLAN, it does carry an environmental risk. Specifically, if growth in particular areas occurs at faster rates or in greater magnitude than projected by the plan, then flows in the new interceptors would be greater than could be accommodated by the proposed sewer lines. That is, in sizing lines to serve a particular growth pattern, without reserve capacity, there may be little margin for error if the city allows a different growth pattern to occur. Thus, careful implementation of the COMPLAN is a prerequisite if the city is to avoid overloaded lines, and the problems such lines would bring - odors, the backup of sewage into homes or streets, a moratorium on hookups, and until the problems are solved, a disruption of orderly development.

Existing lift stations. In addition to the new lift stations discussed above, an analysis of existing lift stations by the facilities plan indicated the need for some repairs and the addition of fail-safe devices in some cases, such as emergency generators and alarms. Impacts associated with existing and proposed lift station improvements are localized and related to construction activities (see next section). In no case would a lift station be constructed within a 100-year flood hazard zone.

Summary. There are two principal impacts of prospective sewerage construction. The first is the long-term effect on land use, which relates especially to the selection of the service area and which was summarized in section 5.2.1. The second is the short-term effect of construction, which is described in section 5.2.3, below.

Three interceptors proposed in the plan (A, B, and C), would correct problems within the existing service area and facilitate new development in the urbanized area (refer to figure 5-3). Line D, to be constructed during the initial part of the planning period, would provide service to currently developing portions of Tier II as well as undeveloped land to the north of town in Tier III; line D also relieves existing overloading in that area. Lines E and G, to be constructed later, would service future growth east of town. Together these last three lines serve the expanded service area proposed in the facilities plan and shown on figure 5-2.

The location and sizing of virtually all facilities is in conformance with the COMPLAN, and will accommodate only that growth (amount, location) projected to occur through the year 2000. For the facilities to work as intended, growth must be as specified in the plan. One facility, the new lift station D, is located such that development could occur in leapfrog fashion, inconsistent with the plan; an alternative site exists which would avoid this impact.

5.2.3 Summary of Construction Impacts

Sewer construction normally involves a sequence of actions, the most significant of which are: surface disturbances, such as by breaking pavement; excavation of a deep but normally narrow trench (less than 10 feet wide); laying of pipe and refill of the trench with necessary compaction and restoration of the original surface. Associated activities include moving of equipment to and from the site, and on-site storage of equipment, pipe and excavated fill. The duration of the sequence at any one site varies according to construction schedules, from a minimum of several days to a normal maximum of several months. During much of this period the site is inactive. The most intense activity occurs during the period of trench excavation and refill, each normally accomplished within one or two working days. More prolonged construction can occur when sewer installations are combined with other utility installations.

Potential impacts from construction are identified in table 5-2. Impacts on earth resources are primarily soil disturbance and possible erosion, which may occur throughout the period of construction. Construction would take place in several settings, each with its own set of environmental constraints.

1. Many of the proposed interceptors would be installed beneath or adjacent to existing streets and roads. Impacts such as dust, noise and traffic disruption are of special concern. One line passes near a wildlife preserve; special measures may be needed to avoid impacts to wildlife (refer to section 6.4.3).

2. Other interceptors are expected to follow existing or proposed rights-of-way along dedicated but unbuilt streets, or along another utility easement. It is likely that construction would precede full development in these areas, and it is probable that in some cases construction would alter a previously undisturbed surface. Specific impacts cannot be identified until detailed routes are selected during project design. In general, impacts such as noise or traffic disruption would be much less than in already developed areas. There would be an increased potential for disturbance of archaeological or biological resources (refer to sections 6.4.3 and 6.5.3).

3. Portions of four interceptors would be located in flood plains. These lines, along Imhoff Creek, Bishop Creek, Normandy (Merckle) Creek, and an unnamed tributary of the Little River, would have special impacts associated with flood and erosion hazards. In some places dewatering may be necessary due to a shallow water table. The impacts, which can be controlled through mitigation measures, are discussed in sections 6.1.3 and 6.2.5.

For the service area as a whole, approximately 14.7 miles of new sewer lines (not including lines E and G) would be installed by the year 2000; most of this would be built in the 1980's. In addition, over 23 miles of sewer

TABLE 5-2. POTENTIAL ENVIRONMENTAL IMPACTS OF CONSTRUCTION ACTIVITIES.

*Indicates effects which may be long-term.

CONSTRUCTION ACTIVITIES	IMPACTS
I. Sewer construction	
A. Obtaining easements and rights-of-way*	Change in land values; change in land use; relocation of families
B. Site clearing/construction of access roads*	Surface change; vegetation change; soil removal and disturbance; change in visual quality; waste disposal; equipment operation; traffic rerouting; archaeological and historic site disturbance
C. Trench excavation, pipe	Surface change; soil removal and disturbance; change in visual quality; dewatering; blasting; equipment operation; traffic rerouting; archaeological and historic disturbance; utility disruption or relocation
D. Site restoration*	Surface change; vegetation change; change in visual quality; waste disposal; equipment operation; traffic rerouting
E. Other activities	
1. Onsite storage of equipment pipe, excavated soil	Surface change; change in visual quality
2. Equipment travel to and fromsite	Equipment operation; traffic rerouting
3. Security and safety	Surface change; change in visual quality; traffic rerouting
4. Support activities (dust control)	Change in visual quality; soil treatment; equipment operation
II. Sewage treatment plant construction	
A. Obtaining easements, rights-of-way, and acquiring site*	Change in land values; change in land use; relocation of families
B. Site clearing and access roads*	Surface change; vegetation change; soil removal and disturbance; change in visual quality; waste disposal; equipment operation; archaeological and historic site disturbance
C. Construction of facilities*	Surface change; soil removal and disturbance; change in visual quality; dewatering; blasting; equipment operation; archaeological and historic site disturbance; waste disposal; equipment operation
D. Site drainage and grading*	Surface change; vegetation change; soil removal and disturbance; change in visual quality; waste disposal; equipment operation; archaeological and historic site disturbance
E. Site restoration*	Surface change; vegetation change; soil treatment; change in visual quality; equipment operation
F. Other activities	
1. Safety fencing*	Change in visual quality
2. Support activities (dust control)	Soil treatment; equipment operation
3. Bypassing sewage	Normally not permitted; if required, special facilities constructed

Source: LWA, 1982.

line not covered by the proposed action must be installed to correct current problems not eligible for funding.

Construction impacts can be significantly reduced by selective use of mitigation measures. The development of such measures would take place in the design and construction phases of each construction project. During project design, alignments would be defined more precisely. Prior to project construction, the contractor must develop any environmental protection plans required by the contract guidelines; in turn these guidelines may reflect conditions of the construction grant. During construction, inspection procedures would be utilized to ensure that the guidelines are followed. Municipal excavation ordinances provide an additional mechanism for review and enforcement of contractor activity.

Throughout the process outlined above, it is important to determine that the measures being taken are cost-effective. This can be accomplished by using flexible contract specifications which establish performance criteria for the contractor, but allow discretion in the selection of control techniques.

Possible mitigation measures which may be appropriate in Norman are listed in table 5-3. A control technique which applies to almost all impacts is to manage the extent of construction to limit the duration of impacts at any one site. This is commonly accomplished by restricting the length of an open trench to the distance between sewer access holes (a maximum of 400-500 feet); in some cases the length of disturbed areas ahead of and behind the trench may also be specified. Since the trenching phase of the project is relatively brief and tends to move rapidly along the line, these restrictions normally ensure that the nuisance impacts of construction are short-lived at each particular location.

5.3 ALTERNATIVES FOR WASTEWATER TREATMENT AND DISPOSAL/REUSE

Norman must construct treatment facilities which will: a) solve the treatment and sludge handling deficiencies described in chapter 4; and b) provide the capacity required by the projected wastewater flow increases (10 mgd by the year 2000). The alternatives involve different kinds of engineering concepts for expanding or replacing the existing plant. These include methods of wastewater treatment (discussed in section 5.3.1) and possible options for wastewater recycling (section 5.3.2). Norman also has considered alternative locations which could be used in place of the existing plant site (section 5.3.3).

5.3.1 Treatment Process Alternatives

To meet the objectives of wastewater management upgrading and expansion, seven alternatives were considered in detail during the facilities planning process. The evaluation of the seven alternatives is described in the

TABLE 5-3. POSSIBLE CONSTRUCTION IMPACT MITIGATION MEASURES.

Note: for Norman, no blasting is proposed, hence measures to mitigate the use of explosive materials are not included in this table.

1. Construction of catch-basins to retard and desilt storm flows from a site.
2. Grade a slight mound along trenches not in street rights-of-way, to provide positive drainage and prevent erosion of backfill earth.
3. On slopes, use excavated soil to direct runoff around construction sites.
4. Schedule construction so that earth-moving is not premature, but begins immediately before actual construction; avoid seasons of high rainfall or wind, if possible.
5. Mark construction or cleared areas on the ground and restrict vehicle activity to marked zones so that unnecessary injury to vegetation is avoided.
6. Reuse excavated materials as backfill or rip-rap, if quality of material is adequate; else dispose of in a sanitary landfill.
7. Provide secure storage for all fuels or chemicals stored on site; use no herbicides or defoliants.
8. Dispose of vegetation spoil by landfill; open burning must not occur.
9. Use dust control measures (watering, soil stabilization, reseeding) where appropriate.
10. Construction noise levels should not exceed EPA and OSHA standards.
11. Minimize danger and interference with traffic by using signals, barricades, flagmen, and traffic rerouting, where appropriate.
12. Protect public from construction hazards by using barriers, signal lights and temporary fencing, where appropriate.
13. Clean up, regrade and seed the altered area immediately upon completion of construction.
14. Minimize aesthetic impacts by maintaining a trim site, providing for proper handling of solid and liquid wastes, and by thoroughly cleaning up site as part of restoration activity at end of project.
15. Cross irrigation canals in winter; where a flowing structure must be crossed, install by boring beneath the structure.
16. There must be no bypassing of sewage.

Source: EPA, 1977b.

facilities plan (PSC, 1981), which includes schematic flow diagrams and detailed cost estimates.

As discussed in section 4.3, the facilities plan was required to plan for treatment to four different levels of effluent quality. Four of the seven alternatives are designed to meet treatment level A (secondary treatment). The remaining three are intended to meet treatment level D (advanced wastewater treatment). The level A options were developed first and an alternative selected. Then level D alternatives were studied assuming they would be added to the selected level A alternative; these advanced treatment alternatives allow for incremental addition of facilities to meet levels B and C. Thus the facilities planning process incorporates into it the flexibility required to respond to any of the wasteload allocation alternatives discussed in section 4.3 by adding on as needed. All of the alternatives are capable of meeting the existing NPDES permit, and all but land application would discharge to the Canadian River.

As identified in the facilities plan, the alternatives are as follows (see the glossary in chapter 10 for definition of technical terms). The first four alternatives are for level A treatment only.

1. Activated sludge (jet system): convert existing aerated lagoons to aerated channels; abandon existing bio-filters (trickling filters); build holding basin for wet weather flows.

2. Activated sludge (jet system) plus bio-filter: as above but retain bio-filters for two-stage biological treatment.

3. Activated sludge (conventional) plus bio-filter: retain bio-filter and convert existing final clarifiers to aeration basins; use existing aerated lagoons for holding wet weather excesses.

4. Bio-filter plus bio-discs: use existing trickling filters as roughing filters, followed by rotating biological contactors (bio-discs, or large drums which turn in the water and on which grow sewage-eating microorganisms); use existing aerated lagoons for holding wet weather excesses.

As discussed below, alternative 4 was selected as the least-cost secondary treatment measure. Then, three additional treatment alternatives were evaluated to provide treatment to level D.

5. Alternative 4 (level A) plus:

   for level B: sand filters for additional BOD and solids removal;

   for level C: conversion of the existing final clarifiers to biological (aerated) nitrification clarifiers surrounded by concentric nitrification aeration basins; nitrification sludge equipment; replace converted clarifiers;

for level D: solids contact units (floculation with lime or alum); a pH adjustment unit (recarbonation using carbon dioxide); a floc carryover basin to minimize carry-over of solids to the sand filters; a chemical sludge pump station and a gravity sludge thickener.

6. Same as above except that breakpoint chlorination (a physical process) is used in place of the aerated or biological nitrification units; dechlorination by sulphur dioxide to remove chlorine residuals.

7. Land application: primary treatment using existing primary clarifiers and aerated lagoons; effluent pumped to a storage lagoon at the application site; wastewater distribution by spray irrigation (see section 5.3.2).

Tradeoff analysis. Table 5-4 lists the dollar costs of the seven alternatives. Alternative 4 is the lowest cost of the four options which would meet treatment level A; alternative 5 is the lowest cost of the options to meet treatment level D. As described in section 4.4, the selection of the most cost-effective alternative is based on factors other than dollar costs. To reflect non-monetary considerations, it is appropriate to use a 'rating table', in which each treatment process is ranked from 1 to 3 based on its performance with respect to appropriate environmental, engineering, and economic concerns.

For the Norman EIS and facilities plan, rating tables were developed by the EIS and engineering consultants, and reviewed through the public participation process (see chapter 7). The resulting ratings are given in table 5-5. Six issues were used in rating the alternatives.

- Dollar costs reflect the economic performance of each alternative. The least expensive alternatives are rated 1. Because of anticipated cutbacks in federal funding, most costs will be paid through substantially increased sewer rates or local taxes.

- Energy use (which is basically an operation and maintenance cost) contributes to dollar costs, but is a separate issue because: a) all energy costs are borne by the local citizens; b) energy conservation is an important national economic and environmental issue. The most energy-efficient alternatives are rated 1.

- Reliability reflects engineering factors; a rating of 1 is given to alternatives which best combine ease of operation, reliability, and process flexibility. Note, however, that successful operation depends much on personnel training and hiring policies.

- Adaptability to differing conditions refers to the potential for changed federal and state regulations, as discussed in section 4.3. Such changes could result in major revisions to the NPDES permit system. A rating of 1 identifies alternatives which are most easily modified in the event permit requirements are altered.

TABLE 5-4. COST SUMMARY OF THE SEVEN TREATMENT ALTERNATIVES.

All costs in 1980 dollars.

Alternative	Initial Capital Cost (Projected Cost)	Site Salvage Value (Land Cost)	Annual Operation & Maintenance Costs	Total Present Worth of All Costs
Level A				
1. Activated Sludge (Jet system)	$ 7,217,000	$ 40,000	$ 605,764	$ 13,451,523
2. Bio-filter and Activated Sludge (Jet system)	7,354,000	40,000	611,764	13,650,275
3. Bio-filter and Activated Sludge (Conventional)	6,344,000	0	575,020	12,262,105
4. Bio-filter and Bio-Discs	6,781,000	0	464,514	11,561,778
Level D				
5. Biological Nitrification	17,554,000	40,000	1,123,914	29,121,323
6. Breakpoint Chlorination	13,850,000	40,000	1,830,363	32,688,093
7. Land Application	40,097,000	7,860,000	1,022,300	47,197,276

Source: PSC, 1981.

TABLE 5-5. RANKING OF WASTEWATER TREATMENT ALTERNATIVES.

1 is 'best'; 3 is 'least desirable'.

	Level A (Secondary)				Level D (Advanced)		
Evaluation Parameters	Alt. 1 Jet Activated Sludge	Alt. 2 Biofilter/ Jet Activated Sludge	Alt. 3 Biofilter/ Conventional Act. Sludge	Alt. 4 Biofilters/ Bio-discs	Alt. 5 Biological Nitrification	Alt. 6 Breakpoint Chlorination	Alt. 7 Land Application
Dollar Costs	3	3	2	1	1	2	3
Operation and Maintenance	3	3	2	1	2	3	1
Reliability	2	1	1	2	2	1	2
Adaptability	3	1	2	1	1	1	3
Environmental Considerations	2	2	2	2	1	1	3
Public Acceptability	3	3	2	1	1	2	3
TOTAL	16	13	11	8	8	10	15

Sources: PSC, 1981; LWA, 1982.

- Environmental considerations encompass factors beyond those covered by the other issues. The rankings distinguish the alternatives on the basis of odor control, resource conservation (water, agricultural land, sewage byproducts, energy), and improvements to water quality. These factors are discussed in chapter 6.

- Public acceptance reflects citizen reactions to the alternatives. Citizen input has placed a high value on those alternatives which: a) are low in dollar cost and energy use; b) provide a near-term solution to the existing treatment problem; and c) are adaptable to possible changes in regulatory requirements.

Dollar costs. Ratings on dollar costs parallel the actual costs listed in table 5-4. Alternative 4, bio-discs, has the lowest total present worth cost, a term which takes into account both capital and operational (principally energy) costs. Alternative 3, conventional activated sludge following roughing filters, is slightly less expensive to construct but much more expensive to operate. Alternatives 1 and 2 are more expensive on both counts. Of the advanced treatment alternatives, number 5 (biological nitrification) is least expensive in total and operational cost, but 6 (breakpoint chlorination) is least expensive to construct.

Operation and maintenance. Ratings with regard to operation and maintenance reflect whether or not a given option is technically sophisticated or relatively easy to run. Bio-discs are rated the best of the level A alternatives, because they are simple to operate. In addition, sludge from this alternative is easier to dewater and fewer operational steps are required in its handling than with sludge from an activated sludge system. Land application (alternative 7) is the simplest of the advanced alternatives.

Reliability. All of the level A alternatives can reliably meet the requirements of the existing NPDES permit. However, some of the options involve processes which are especially stable and likely to perform well over time. For example, alternatives 2 and 3 combine a fixed film reactor (water passing over media) with activated sludge, where the amount and rate of activity of microorganisms can be better controlled. Alternative 2 has the further advantage of having a longer detention time, making it even more adaptable to diurnal demands and permit variations.

The land application alternative and other level D treatment alternatives can produce a final effluent meeting the most stringent effluent requirements. Breakpoint chlorination (alternative 6) is deemed more reliable than biological nitrification, with respect to the ammonia removal operations. The land application alternative is generally less reliable since it is dependent on climatic and hydrologic factors.

Adaptability. Alternative 4 is considered especially adaptable because it produces a sludge similar to that of the existing plant, and thus fits in well with existing facilities. Alternative 2 is also adaptable because the processes used have a long detention time, which enables the process to treat to a wide range of standards. Alternative 1 is the least adaptable, because it involves a single process which cannot be easily scaled down in the event that standards are changed.

The land application alternative is the least adaptable of the advanced treatment alternatives, because it is dependent on climatic and hydrologic factors. It also can not be modified according to the level of treatment required.

Environmental considerations. This category is primarily concerned with water quality. The level D alternatives produce the best effluent, and receive a ranking of 1. All of the level A alternatives will produce about the same quality of effluent; thus, all are ranked the same. Other environmental factors (e.g., potential to minimize odor problems) are considered equivalent, except that land application is downrated for reasons discussed in section 5.3.2.

Public acceptability. Because the treatment alternatives are broadly comparable in most respects, but differ substantially as to dollar costs, public input to date has emphasized economics as the major factor determining public acceptability. Therefore the rankings in table 5-5 reflect the total present worth costs set forth in table 5-4.

Assuming that each issue is of equal importance, simple addition of the ratings gives a total score for each alternative; the options with the lowest score are rated best. The results are shown in table 5-5 and indicate that alternative 4 (bio-discs) and alternative 5 (biological nitrification) appear to be the preferred options for their respective treatment levels.

5.3.2 Alternatives for Wastewater Reuse

Except for land application, none of the treatment alternatives propose to reuse wastewater. However, one potential customer for reclaimed water was identified late in the planning process. The University of Oklahoma is preparing a separate plan to utilize treated wastewater for golf course irrigation. This plan would involve construction of a dam on Bishop Creek to intercept surface runoff for irrigation purposes; during summer months, peak demand on the reservoir possibly would be met by pumping a maximum of 0.3 mgd of treated wastewater to the reservoir. The cost of the pump and pipeline for this project is estimated at $150,000, which would be paid for by the University. Whether wastewater will be used will depend on the total cost of the project once bids have been made. Construction could begin as early as mid-1982, though a specific agreement with the city has not yet been reached (Yanda, 1982).

Land application provides a combination of wastewater treatment and reuse, and was considered in the facilities plan. The wastewater would receive primary treatment, prior to use on farms; controlled irrigation with the water would provide substantial additional treatment of organic matter, nutrients, pathogens, and many other contaminants. This alternative would reduce the discharge to the river, which would reduce the potential of the river to provide beneficial uses that relate to quantity. On the other hand, quality impacts of wastewater discharge would be eliminated if land application is implemented. Public input indicates a desire to utilize land application, if feasible.

The land application alternative would require 3930 acres of land to treat all of Norman's design-year sewage. Possible sites for land application had been evaluated in a report by Engineering Enterprise, Inc. (EE, 1974); a site south of the treatment plant, within the corporate limits of Goldsby, was recommended. Review by the facilities plan engineers determined that this was indeed the only practical site. Most of Norman is in the Little River watershed, where wastewater discharge is prohibited. The only other area of adequate size is the Ten-Mile Flats area in west Norman. Most of this land is within the 100-year floodplain and therefore unacceptable for wastewater disposal. Furthermore, land prices in that area are high. (It was determined that the city would have to purchase land, because long-term contracts from farmers for the use of wastewater could not be obtained.)

Based on the facilities plan, there are many practical problems with the land application alternative. Use of the Goldsby site would displace numerous residences. Ponds used to store wastewater during cool or rainy periods would represent a potential odor source. Land application would be very expensive; this expense would be due primarily to construction costs for the pipeline and the storage ponds, and so would be high regardless of the site chosen. For these reasons, land application does not appear to be a viable alternative.

5.3.3 Alternatives for Plant Location

Alternatives to the existing location of the treatment plant were considered in the initial screening phase of the facilities plan. Any other site must still be within the Canadian River basin, since wastewater discharge is prohibited in the Little River basin. Locations upstream of the existing plant would require that wastewater be pumped; this would be expensive and energy-intensive. Downstream of the existing site, there is little area within the city limits. The main advantage to relocating the plant downstream would be to facilitate service to additional areas in Norman; however, the additional area thus served would be small. Futhermore, a new plant location would not make use of existing facilities at the treatment plant, and so would be more expensive. For these reasons, alternative plant locations were screened out.

5.4 ALTERNATIVES FOR SLUDGE MANAGEMENT

Sludge (residual solid material) is a major product of wastewater treatment. Sludge is a rich organic material that, prior to treatment, contains significant amounts of pathogens (disease-causing organisms), nitrates, and heavy metals (especially if much industry discharges to the treatment plant). If improperly treated and disposed of, sludge can be the source of problems such as odors, ground-water contamination, and gastrointestinal disease. On the other hand, if properly managed, sludge can be a valuable resource. It is a good soil conditioner and has some fertilizer value. Alternatively its energy content can be captured and used to create steam or electricity. Thus, a primary purpose of facilities planning is to determine the best methods for: a) treatment to stabilize the sludge (that is, to reduce pathogens and odors); and b) disposal or reuse of this material in an environmentally sound manner.

Presently, sludge from the Norman treatment plant is treated and disposed in two separate ways. Primary sludge (solids which settle out in the primary clarifiers) is thickened and then sent to anaerobic digesters for stabilization. The digested sludge is disposed by wet injection on sites to the north and south of the treatment plant. Some of these sites are within the 100-year floodplain, and therefore do not meet EPA regulations for sludge disposal (40 CFR 257). Also, the city does not own these sites, but uses them by verbal agreement with the farmers who do. Secondary sludge (from the intermediate and final clarifiers) is treated in aerobic digesters, dewatered on sludge drying beds and then sold to the public for use as a soil conditioner. This practice is not acceptable under current EPA regulations because of possible hazards due to pathogens and heavy metals in the sludge. The aerobic digesters do not function well, and so secondary sludge is sometimes mixed with primary sludge in the anaerobic digesters.

Currently under evaluation is the possibility of mixing Norman's sludge with soil and using the mixture to "cap" the city's landfill. This would occur only over the next 3 to 5 years, and does not provide a long-term solution for sludge disposal.

Development of alternatives. As is clear from the above-mentioned problems, neither the present treatment nor disposal facilities will be adequate for future management of Norman's sludge, and so it was necessary for the facilities plan to develop alternatives for new facilities. There are many options for each potential step of sludge management (thickening, stabilization, dewatering, further treatment, disposal) and the possible combinations are numerous. Four specific alternatives for sludge management were developed in the facilities plan, as follows.

1. Primary sludge to be treated by anaerobic digestion and disposed of by wet land application; secondary sludge to be treated by lime conditioning, dewatered by vacuum coil filters, and disposed of by land application of dry sludge.

2. All sludge to be treated by anaerobic digestion and disposed of by wet injection (land application of wet sludge).

3. Treatment by lime conditioning, dewatering by vacuum coil filters; resulting material mixed with municipal refuse and incinerated; ash disposed of to landfill. There are two suboptions:

  - 3a. Use heat to produce both steam and electricity (codisposal/cogeneration).
  - 3b. Use heat to produce electricity only (codisposal/electricity production only).

4. Treatment by lime conditioning, dewatering by vacuum coil filters; incineration (without heat recovery); ash to landfill.

All alternatives include thickening of the sludge as a first step. If bio-disc treatment is selected for wastewater treatment, gravity thickening would be used; for activated sludge alternatives, thickening would be by air flotation.

Unlike the wastewater treatment options, selection of the preferred sludge management alternative has engendered controversy. Thus, it is appropriate to explain the alternatives in some detail.

Except for alternative 2, all alternatives call for dewatering of the sludge to a dry cake, using vacuum coil filters. Such dewatering is necessary for the incineration alternatives (3 and 4), in order for the sludge to burn properly. In the case of alternative 1, there would be an option to by-pass the dewatering step and dispose of the sludge by wet land application. Sludge is somewhat resistant to dewatering; in order to achieve the desired solids content (20 to 25 percent) it is necessary to condition the sludge prior to dewatering. This can be by addition of one or more chemicals, such as lime, polymers, and ferric chloride. In the case of alternative 1, lime conditioning serves also to stabilize the sludge (that is, it significantly reduces pathogens and halts odor production); thus, more lime would be used for the conditioning step in alternative 1, and this step would be included even if the sludge were not to be dewatered.

Alternatives 1 and 2 retain use of the plant's existing anaerobic digesters; alternative 2 would additionally require new digesters. Both these alternatives would ultimately dispose of the sludge by land application. The proposed land application site is shown on figure 5-5. This site was selected by the engineer after meetings with the Oklahoma State Department of Health and consideration of regulations governing land disposal of sludge. Disposal of liquid sludge would be by wet injection. Dewatered sludge would be spread and plowed under.

Alternatives 3 and 4 both involve incineration of the sludge; the difference is that alternative 3 mixes the sludge with municipal refuse prior to incineration. This enables the recovery of heat, with a net energy gain, and possibly qualifies the alternative as innovative technology, eligible for 85 percent EPA funding, rather than 75 percent. No heat recovery is possible from incineration of sludge by itself (alternative 4); in fact, addition of fuel would be required to keep the sludge burning. Ash from the incineration alternatives would be disposed of by landfill (see figure 5-5).

The above alternatives are for treatment of sludge from level A treatment. If level D treatment is required, there would be lime sludge from

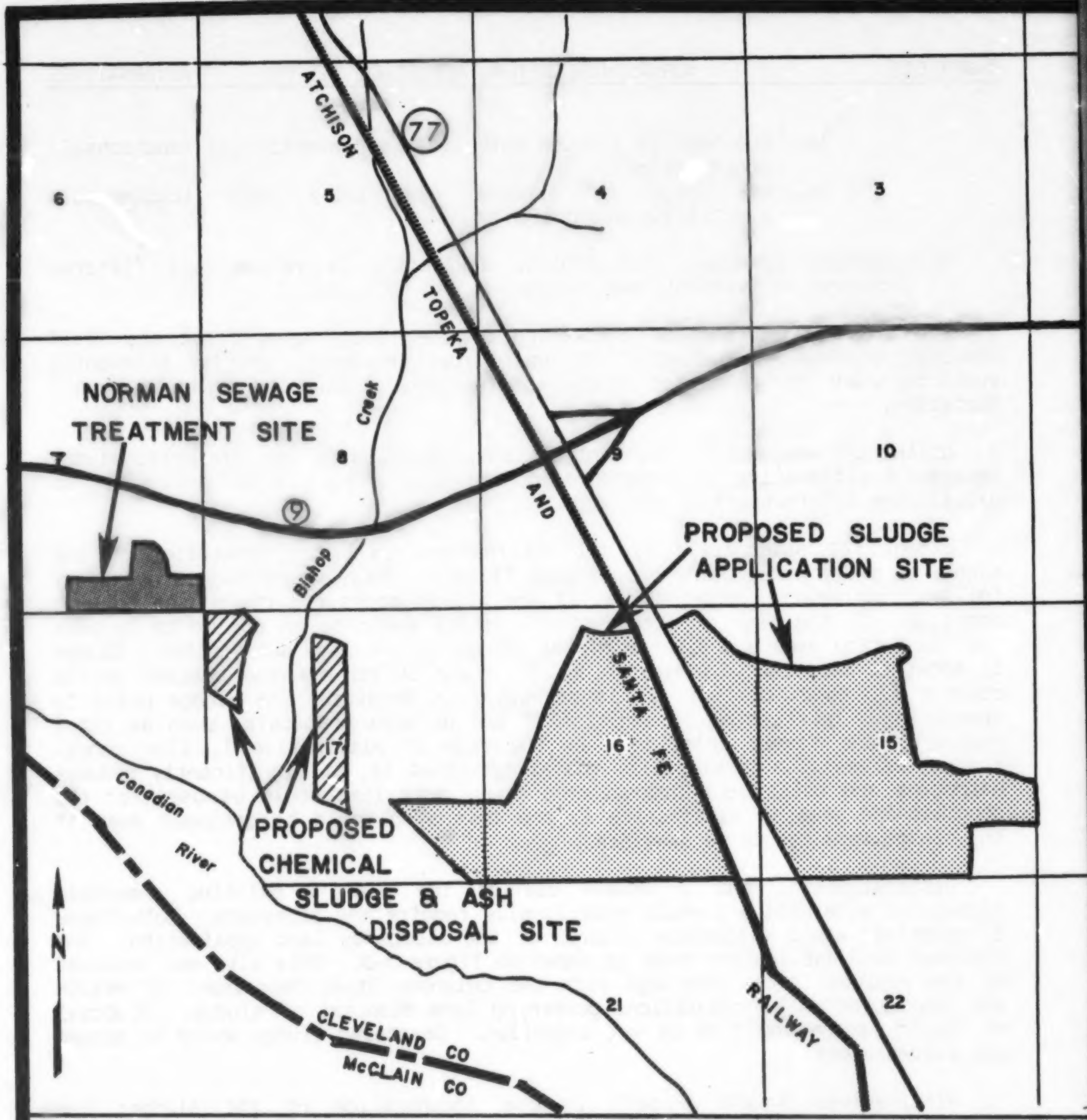

ATCHISON
77
TOPEKA
AND
SANTA FE
RAILWAY
6
5
4
3
7
8
9
10
NORMAN SEWAGE TREATMENT SITE
Bishop Creek
9
PROPOSED SLUDGE APPLICATION SITE
16
15
17
PROPOSED CHEMICAL SLUDGE & ASH DISPOSAL SITE
Canadian River
N
21
22
CLEVELAND CO
McCLAIN CO

FIGURE 5-5.

SLUDGE DISPOSAL

Source: PSC, 1981.

the solids contact units. This would be stored for several years in decant ponds; then the dewatered "chemical sludge" would be disposed of at a landfill site (see figure 5-5). There would also be some additional sludge from the nitrification basins; the amount would be very small and the capacity planned for level A treatment should also accommodate this nitrification sludge.

Tradeoff analysis. Costs from the various alternatives are presented in table 5-6. Each of the four alternatives presents both advantages and disadvantages. The tradeoff analysis weighs these factors against each other in order to determine the applicant's preferred approach to sludge management. The analysis was much more extreme than for wastewater treatment alternatives, because factors other than treatment economics here play major roles in the decision-making process.

The four alternatives were ranked on their relative costs and benefits according to a number of criteria, similar to (but more detailed than) the approach used for wastewater treatment alternatives. The results are summarized in table 5-7. This table incorporates engineering evaluations from the facilities plan plus environmental considerations. Total points for each alternative are given, with a lower score indicating a "better" alternative. However, note that the criteria are not weighted; that is, each factor is treated with equal importance by the rating scheme. Should public opinion consider a particular criterion to have overwhelming importance, an alternative which meets that criterion might be favored, even if it has a higher point score on table 5-7.

The criteria used to evaluate the alternatives can be divided into four categories (with some overlap). Category one is resource use, that is, the amount of money, energy, labor, materials, and real estate that a given sludge handling and disposal system consumes. Alternatives 3 and 4 are energy intensive, whereas alternatives 1 and 2 require large amounts of land. In terms of dollar outlay, alternative 4 (incineration) is much more costly than the other alternatives. Alternative 1 uses large quantities of chemicals (lime).

Balancing resource use is the potential of resource recovery. Sludge-related resources potentially include: methane gas, which can be burned to heat digesters or to generate energy for operation of the treatment plant; the sludge itself, used directly a soil conditioner; and energy from burning the sludge to generate heat, electricity, and/or steam.

For alternatives 1 and 2, the final sludge product is an organic material which has some fertilizer value and is a good soil conditioner. Sludge applications improve soil properties such as humus content, fertility, water-holding capacity, cation-exchange capacity, and soil aggregation. Nitrogen and phosphorus generally make up 2-3 percent of a typical municipal sludge, which in itself does not make the material a complete fertilizer. However, the nutrients are in the organic form and are released to the soil slowly, which is an ideal trait for a soil conditioner. There are some hazards associated with sludge application: potential leaching of nitrates

TABLE 5-6. SUMMARY OF COSTS OF SLUDGE MANAGEMENT ALTERNATIVES.

Alternative	Total Capital Cost	Annual O&M	Annual Revenue	Total Present Worth
1. Lime Conditioning; Land Application				
Level A: =	1,807,650	2,162,810	a/	$ 4,073,380
Level D: =	2,392,744	4,216,064	a/	$ 6,711,728
2. Anaerobic Digestion; Land Application				
Level A: =	2,821,726	1,618,057	a/	$ 4,439,783
Level D: =	3,406,820	3,671,311	a/	$ 7,078,131
3a. Codisposal/Cogeneration				
Level A				
total =	8,379,000	824,920	1,250,930	$ 3,994,505
sludge portion =	4,608,450	453,706	688,012	$ 2,196,978
Level D				
total =	9,129,000	954,920	1,350,830	$ 6,082,465
sludge portion =	5,751,270	601,600	851,023	$ 3,831,953
3b. Codisposal/Electricity				
Level A				
total =	9,698,000	831,120	833,080	$ 9,677,828
sludge portion =	5,236,920	448,805	449,863	$ 5,226,027
Level D				
total =	10,448,000	961,120	895,530	$11,765,788
sludge portion =	6,477,760	595,894	555,229	$ 7,294,789
4. Sludge Incineration				
Level A: =	5,509,000	502,070	b/	$10,676,304
Level D: =	6,259,000	632,070	b/	$12,764,264

a. Possibly some cost recovery from methane combustion.
b. Possibly some revenue from heat recovery.

Sources: PSC, 1981; PSC, 1982.

TABLE 5-7. COMPARISON OF SLUDGE MANAGEMENT ALTERNATIVES.

Rankings of 1 (best) to 4 (least desirable) are accompanied by quantification of impact which is associated with rating.

Factor		Alternative 1: Primary - anaerobic digestion; secondary - lime conditioning; land application		Alternative 2: Anaerobic digestion; land application		Alternative 3: Codisposal CG = cogeneration (steam) E = electricity only		Alternative 4: Incineration
A. RESOURCE USE								
Dollar Costs (Total Present worth)	2	Level A: $4,073,380 Level D: $6,711,728	2	Level A: $4,439,783 Level D: $7,078,131	1	CG (sludge portion only) Level A: $2,196,978 Level D: $3,831,953	4	Level A: $10,676,304 Level D: $12,764,264
					3	E (sludge portion only) Level A: $5,226,027 Level D: $7,294,789		
Energy Use (Equivalent million BTU/yr)	1	4487	1.5	Not available; would be somewhat more than alt. 1	3	CG 18,580 E 18,580	4	27,460
Chemical Use	4	286 tons/ yr of lime	1	None needed	2.5	Some lime, polymers or ferric chloride needed	2.5	As alt. 3
20-year Land Requirements	4	Level A: 275 acres Level D: 747 acres	3.5	Level A: 205 acres Level D: 572 acres	1.5	Level A: 20 acres Level D: 80 acres	1	Level A: 4 acres Level D: 64 acres
SUBTOTAL	11		8		8 9.5	CG E	11.5	
B. RESOURCE RECOVERY								
Energy production (Equivalent million BTU/yr)	3	Potential to recover energy from anaerobic digestion methane	2	As alt. 1, but quantity of methane would be much greater	1	CG 72,280 E 49,320	4	Probably not cost-effective to recover energy
Fertilizer Value	1	Most nutrients retained; lime treatment is good for OK soils	2	Nutrients retained, but wet sludge difficult to apply to crops	4	None	4	None
Cost Recovery Potential	2	Possibly could stockpile dried sludge for about a year and then bag & sell	3	Little potential. Perhaps could "mine" humic soil at application site to bag and sell	1	Can sell electricity and steam.	4	Some heat recovery possible though much less than alt 3
SUBTOTAL	6		7		6		12	
C. OPERATION								
Ease of Implementation	2	Relatively easy. Uses some existing facilities	1	Easy start-up and shut-down	4	Requires building of complex facility; ordinances for refuse collection; change in refuse operation	3	Requires building of complex facility

Table 5-7. Continued.

Factor	Alternative 1: Primary - anaerobic digestion; secondary - lime conditioning; land application		Alternative 2: Anaerobic digestion; land application		Alternative 3: Codisposal CG = cogeneration (steam) E = electricity only		Alternative 4: Incineration	
C. OPERATION (cont.)								
Ease and Flexibility of Equipment Operation	2	Lime feed and vacuum coil filter equipment	1	Operators already familiar with process; only alternative that doesn't use vacuum coil filters	4	Relatively sophisticated equipment. Need to coordinate with municipal refuse	3	Relatively sophisticated equipment
Process Control (reliability)	2	Good control with lime conditioning process; digestion portion is a biological process, subject to upsets	3	Biological process, subject to upsets	4	May be some difficulty in getting right proportions of sludge and refuse; system subject to breakdown if fed improper refuse	1	Physical process, easy to control; can add fuel as needed.
Safety	2	Little danger from process; does involve use of caustic lime	1	Little danger from process	4	High temperatures, high voltage, steam, electrical equipment	3	High temperatures
SUBTOTAL	8		6		16		10	
D. IMPACTS								
Odor Potential	3	Primary potential from digesters; lime conditioned sludge should be relatively odor-free.	4	Primary potential from digesters; possible odor at disposal site; may affect some residences	1	No odor from incineration	1	No odor from incineration
Bacteria/Viral Safety	3	Must control public access; pathogens reduced by lime conditioning	4	Public access must be controlled for one year after land application.	1	All pathogens would be destroyed by incineration	1	As alt. 3.
Air Quality Impacts	1	Minimal	1	Minimal	4	Possible problems; scrubbers would be required	3	As alt. 3; less bulk to be incinerated
Potential for Ground Water Pollution	3	Possible; application site must be monitored	4	Potential greater than alt. 1, since sludge is applied wet	2	Some potential for pollution from ash disposal site	1	As alt 3., but less ash volume
Public Acceptance	2	Much like present system, which public approves of	1	Most like existing system which public approves of	3	High capital cost; complex technology; probably not cost-effective for refuse	4	Very costly; no resource recovery
SUBTOTAL	12		14		11		10	
TOTAL RATING	37		35		41 42.5	CG E	43.5	

Sources: PSC, 1981; LWA, 1982.

from the application site into the ground water; build-up of heavy metals (especially cadmium) in the soil and in vegetation grown at the site; potential bacterial or viral infection of persons who come into contact with the sludge.

Alternatives 1 and 2 take advantage of sludge's fertilizing and conditioning properties by applying the sludge to land where it can then be utilized by crops such as hay and alfalfa. With alternative 1, which proposes to produce a dry lime-conditioned sludge, it is also possible that the city could bag and sell the sludge, thus recovering most or all of the sludge treatment costs. Under present EPA regulations (40 CFR 257), the sludge could not be sold until testing indicates that pathogen levels were sufficiently reduced. This would require stockpiling of the sludge for a year or more. Also, EPA regulations are currently undergoing revision, and conceivably could disallow any bag and sell operation in the future. Thus, the facilities plan calls for final land application of the sludge; however, depending on changes in regulations, sale of the sludge may be an option in the future. Since alternative 2 produces a wet sludge, a direct bag and sell operation is not feasible. It may be possible in the future to recover and sell the humic soil from the injection site.

Alternatives 3 and 4 both involve incineration of the sludge, which would destroy its fertilizer value. On the other hand, the energy content of the sludge, which is released as heat during incineration, can be recovered and used to generate steam and/or electricity. The amount of heat recovery from alternative 4 would be relatively small and probably would not be worth the cost of heat recovery equipment. Alternative 3 enhances heat recovery from the sludge by incinerating it with municipal refuse (the mixture burns more efficiently than sludge alone). The difference between alternatives 3a and 3b is that the former would produce both steam and electricity for sale, the latter would produce electricity only. The cost analysis indicates that alternative 3a would produce more revenue; however, it should be noted that at present there is no identified customer for the steam.

Some energy recovery is also possible from alternatives 1 and 2, in the form of methane from the anaerobic digesters. The amount of recoverable methane would be greater under alternative 2, since all sludge would be digested. Dollar worth of the potential heat and electricity from methane combustion was not evaluated in the facilities plan. Methane probably would provide at least enough energy to heat the digesters, and perhaps energy in excess; however, impurities in sludge gas result in expensive maintenance of the methane burning equipment, and so this option was not regarded as cost-effective.

Thus, to summarize resource recovery: alternative 3 has the best rating because of the large potential revenues from electricity and steam production; alternative 1 is next best, because of its use of sludge as a fertilizer and soil conditioner, and because of the potential to generate revenue by sale of the sludge product. Alternative 2 also utilizes the organic value of sludge, and could potentially provide energy due to methane production. Alternative 4 provides the least use of sludge's resources, because the organic value is destroyed, with no energy recovery.

The third category of evaluation factors given in table 5-7 deals with the operation of the sludge facilities. "Ease of implementation" refers to the amount of effort required to get the sludge management system in operation. Alternative 2 simply requires installation of some new digesters and purchase of the wet-injection trucks. This alternative is also the easiest to abandon if another option is preferred in the future: the digesters could be converted to storage tanks and thickeners, the trucks could be sold, little investment in the system would be lost. Alternative 1 requires the installation of vacuum coil filters and lime-feed equipment. Alternative 4 requires installation of relatively complex incineration equipment. Alternative 3 is the most difficult to implement because it requires building a large, complex incineration facility, with much of the funding not eligible under an EPA construction grant. Ordinances restricting the type of refuse the city can handle must be passed, and the public must be educated to conform to the restrictions. The sanitation department must be coordinated with the sewage department.

Alternatives 3 and 4 generally present greater problems in operation, because they involve sophisticated technology; in particular, alternative 3 requires a much larger facility to accommodate the combined bulk of refuse and sludge. Alternatives 1 and 2 use somewhat less advanced techniques, which are more familiar to the existing staff. However, the processes of alternatives 1 and 2 are subject to upsets which may be outside operator control (e.g. if a slug of toxic material discharges to the system).

The fourth evaluation category reflects various environmental impacts. Sludge is one of the greatest sources of odor at a treatment plant, and therefore the alternative selected has ramifications for the overall public acceptability of the treatment plant. Alternatives 3 and 4 are given the best rankings because the incineration process should not produce significant odors. Alternatives 1 and 2 both pose the potential for odors from the land application site. The proposed site borders on Tier II land zoned for residential development. Since the general wind direction is from the south, and the land application site is south of the urbanizing area, there may be odor impacts on citizens in new developments adjacent to the disposal site. However, odors should be minimal since the sludge is to be incorporated under the soil.

Land application of sludge can have adverse impacts on ground water due to leaching of nitrate from the disposal site. There is also danger of heavy metals accumulating in the soil to toxic levels; cadmium is of special concern. The land application rate for sludge proposed in the facilities plan is designed to avoid these problems. Appendix 7 of that document presents calculations which show that, based on sludge cadmium concentrations and the sludge application rate, cadmium levels would not accumulate in the soil to levels beyond that allowed by EPA regulations. The application rate is also designed to provide no more nitrogen than would be taken up by crops grown on the site. In addition, the soils and ground water at the application site would be monitored to insure that pollutant levels stay within acceptable levels. Sludge disposal is permitted by the Oklahoma State Department of Health; they would review the final land application and monitoring design for adequacy of environmental protection.

Alternatives 3 and 4 have only a small potential for ground-water pollution, from the ash disposal site. The ash landfill would be constructed and operated to avoid any such problem; again, the disposal design would be approved by the Department of Health prior to implementation. On the other hand, these two alternatives have the potential for adverse impacts on Norman's air quality. The major air pollutant from sludge incineration is particulate matter, which must be removed by some type of pollution control equipment. If improperly handled during disposal, incineration ash can also cause particulate pollution. Other emmissions include sulfur dioxide, nitrogen oxides, hydrocarbons, and hydrogen chloride gas. Depending on the quality of the wastewater, sludge incineration emmissions may also contain toxic metal and organic compounds. Because of the much greater volume of material incinerated under the codisposal alternative, it has the greatest potential to contribute to air quality problems. See section 6.3.5 for further discussion of air quality impacts of incineration.

Another environmental impact of concern to sludge disposal is bacteria and viruses in the sludge which have the possibility to cause disease if the public comes in contact with the sludge (this danger decreases with time, since the pathogens eventually die off). Alternatives 3 and 4 would eliminate this problem by incineration of the sludge, but there would be a potential hazard with alternatives 1 and 2. Alternative 1 is given a better rating, because lime conditioning can destroy a significant amount of pathogens. For either land application alternative, the application site would be fenced off to prevent public access, thus limiting exposure to the pathogens.

Public acceptance is included in this section, since to choose an unpopular alternative would presumably have a negative impact on people's perception of their environment. Initial comments indicate opposition to alternative 3 because of its high capital costs and complex technology, and because incineration of municipal refuse is not favored. Alternative 2 is favored because it is easy to implement, and could easily be modified if a different sludge management system became desirable in the future.

The total ratings in table 5-7, based on simple addition of all individual ratings, indicates that alternative 2 is preferable, followed by (in order) 1, 3a, 3b, and 4. The favorable rating for alternative 2 reflects its simple technology, ease of implementation, and acceptability to the public. In turn, acceptability reflects the adaptability of this alternative to potential changes in regulatory policies. Alternative 1 is slightly more complex and resource intensive than alternative 2, but it has a somewhat lower cost.

At first glance, alternative 3 is very attractive because of the net gain in energy and the low total present worth. But a second look indicates several problems with this alternative. The low cost of codisposal/cogeneration (3a) assumes sales of the steam generated, but to date no steam customer has been identified. If only electricity is produced (3b), codisposal is more expensive than land application. Furthermore, the costs presented in the rating table refer only to the sludge portion of the codisposal facility (i.e., that part eligible for EPA funding). As seen in table 5-6, the total cost of the facility would be much more. Also, even if alternative 3 is cost-effective for sludge disposal, it is not necessarily cost-effective for refuse disposal. Currently, the cost for refuse disposal in Norman is about $4/ton; the projected cost under the codisposal alternative would be $12/ton, a three-fold increase.

While the concept of using sludge and refuse as energy resources is very appealing, benefits are offset by the complex technology required, the potential for operational problems, the potential for air quality degradation, and the uncertainty of customers for the energy produced. These difficulties generally make incineration a viable option only in areas where land is unavailable or unsuitable for waste disposal. Norman does not have such a land shortage, and therefore prefers land application as the better option for sludge disposal.

5.5 OTHER ALTERNATIVES

The development of a complete wastewater management system requires consideration of many factors beyond basic treatment concepts. This section discusses methods for addressing the remaining components of an effective facilities plan (keeping in mind that the plan, like the EIS, is a draft document subject to revision). For many components the planning effort developed a single 'most effective' approach, because of the general need to provide the best practicable treatment works in Norman.

5.5.1 On-Site Systems; Septage Disposal

Individual liquid waste disposal systems (on-site systems, or OSS) may constitute a nonpoint-source of pollution. The ACOG 208 reports estimated 1,000 OSS within Norman's corporate limits, 90 percent in the Lake Thunderbird watershed (ACOG, 1977e). Central Oklahoma Master Conservancy District records indicated over 5,000 systems by 1982 for the entire Lake Thunderbird watershed, including Norman, Moore, Oklahoma City, and unincorporated areas (Brown, 1982). At present, septage (septic tank pumpings) is disposed of at the Norman wastewater treatment plant or at other treatment plants in the area.

Nearly all OSS in the area are single-chambered septic tanks with tile drainfields. Installation of OSS is subject to Oklahoma State Department of Health (OSDH) rules and regulations (table A-2) and to municipal and county minimum lot sizes. Minimum allowable lot sizes are one acre in unincorporated areas governed by OSDH regulations; within the Lake Thunderbird watershed, city of Norman regulations set a minimum lot size of 5 acres.

Suitability of OSS in a particular area depends on a number of factors, including regulations governing their use, suitability of local soils and terrain, and hydrologic conditions. Conditions in the Norman area are generally favorable (refer to section 6.1.1) except for bottomland soils such as those in the Ten Mile Flats area, on the west edge of Norman, where shallow or seasonal ground water can be a problem.

If not strictly regulated and properly designed, installed and maintained, septic tank/drainfield systems can cause water pollution. Septic tank effluent is normally rich in organic matter, nutrients, metals, bacteria and viruses. In passing through the soil, wastewater is usually renovated to some extent, depending on site-specific conditions. However, as different pollutants respond to differing soil conditions, total renovation of on-site effluent is unlikely under any conditions.

No specific health problems are known to have resulted directly from the use of OSS in the Little River Basin (Brown, 1982). ACOG (1977e) noted that coliform bacteria were found in OSDH samples from Moore and Hall Park water systems, which derive water from shallow terrace and alluvium deposits, but the source of the bacteria was not determined.

An alternative to the existing situation would be to upgrade the on-site system regulations, and to undertake a long-term monitoring program to determine if any build-up or movement of nitrate or other pollutants is occurring.

5.5.2 Disinfection

Disinfection of wastewater is necessary prior to discharge to the South Canadian. Continued chlorination is the only alternative considered in the facilities plan. Any other alternative would be more expensive, and would be considered only if chlorination caused significant problems. Such problems could reflect several adverse effects of chlorine use: possible production of carcinogenic by-products; chlorine residuals which can be toxic to aquatic life; the transport of a hazardous material through neighboring communities; and ineffectiveness in killing viruses and parasites.

These problems are not considered severe in Norman. The aquatic life in the South Canadian is limited due to the intermittent nature of the stream, and fish species which are most susceptible to chlorine toxicity (e.g. trout) do not exist in the South Canadian below Norman. Also, the amount of material subject to hazardous transport is relatively small. Nonetheless, continued use of chlorine for disinfection does involve some environmental risk which could be reduced through use of more expensive disinfection techniques.

5.5.3 Energy Conservation

The energy consumption of treatment alternatives is discussed in sections 5.3.1 and 6.7.3, and was a major factor leading to the facilities plan recommendation of bio-discs, which use less energy than other treatment options. The energy implications of sludge management alternatives are discussed in section 5.4. Codisposal can produce electricity and steam, for a net gain in energy. The sludge alternative which rates best overall, anaerobic digestion and land application, could produce energy in the form of methane gas.

Energy conservation measures related to detailed design of the treatment system (e.g., selection of energy efficient motors; insulation of digesters; use of air lift pumps) will be considered in the next phase of design of the wastewater management system.

5.5.4 Odor Reduction

The treatment plant has been a source of odors since modifications were last made to the plant in 1975. At that time, alterations to treatment units increased the elevation at which wastewater entered the facility. As a result, incoming wastewater backs up (surcharges) within a major interceptor before reaching the elevation required to enter the plant by gravity. The surcharged wastewater typically becomes septic, and once in the plant results in odors at the trickling filters and other facilities. A diversion box was installed to reduce the problem, but was only intended as a temporary measure. As the wastewater load has continued to increase, the surcharging has also increased, as have odors.

To alleviate the existing odor problem, the facilities plan proposes to install a screw pump lift station of sufficient capacity to eliminate the surcharging and thus reduce the odor problem considerably. However, a faint musty odor is likely to remain, as this is a normal condition of the use of trickling filters.

Additional odors from proposed facilities should be minor. The bio-discs would be covered by fiberglass enclosures. Storm water temporarily stored in the converted aerated lagoon will be aerated to prevent odors. Similarly, sludge stored in the converted aerobic digesters will be aerated. Odor potential from the advanced treatment units would also be minimal, as wastewater passing through these units will already be well treated; sludges produced by these units would be low in odor-causing organic matter. Final lime sludges would be buried; other sludges would be injected or turned under immediately, thereby reducing odor potential. See section 6.3 for further discussion of odors.

5.5.5 Water Conservation

The existing average per-capita wastewater contribution to the treatment plant is about 95 gallons per day, including industrial and commercial sources. The facilities plan has used 100 gallons per capita per day for the purpose of designing proposed facilities. EPA guidance indicates that flow reduction measures should be considered in the facilities planning process. The facilities plan indicated that water conservation (flow reduction) in Norman must be considered as part of the city's building code program. Possible measures would include regulations requiring new buildings to have water-saving toilets, low-flow showerheads, and hot-water pipe insulation.

5.5.6 Other Pollutant Sources

A major water-quality issue in Norman is the protection of Lake Thunderbird. In particular, urbanization of the Little River watershed may increase pollutant loadings to the lake. This issue is reviewed in some detail in LWA (1982a), with emphasis on the nutrient phosphorus, a pollutant for which considerable data are available and which is known to be important to the long-term usefulness of the lake. The results of the study are presented in section 6.2 of this EIS.

The available information indicates that most of the phosphorus flushed into Lake Thunderbird derives from natural and accelerated soil erosion. In turn, the phosphorus in the soil is part of the natural soil material, or has been added from sources such as fertilizer use, on-site system discharges, rainfall, dustfall, and decay of vegetation. It has yet to be determined if urbanization has a major impact on the quality of the lake, but the magnitude of projected development certainly raises the prospect that such impacts may occur; if not within the next 20 years, then possibly at a later time (see section 5.2.2). Thus, it is timely to consider potential measures to control phosphorus loadings to Lake Thunderbird.

For control measures to be most effective, it would be necessary to have a good understanding of the relationships between land use in the watershed and water quality in the lake. As discussed in LWA (1982a), such an understanding is difficult to obtain given available data and methods of analysis. Generally, other areas faced with this situation have decided to wait until more information is available before implementing major programs to control nonpoint-source pollution.

To a considerable extent, the information needed to address this issue will be developed through regional and national research programs which are concerned with the dynamics of stressed lakes. However, it does appear that the origin, erosion, transport, and ultimate fate of sediment-related phosphorus is critical to an evaluation of specific conditions in the Little River watershed and Lake Thunderbird. Thus, local research is appropriate on several subjects, such as: quantification of phosphorus (or other parameters) in different soils, and the ultimate role of various sources in contributing to the presence of this nutrient; the effects of urbanization in changing erosion and sediment-transport patterns, with emphasis on the benefits of the many small ponds in the watershed; the extent to which phosphorus (or other parameters) is permanently bound to sediment in Lake Thunderbird, and the circumstances under which these materials may be released into the lake and become available to aquatic organisms; the dynamics of algal populations (biomass, primary production, species composition) in the lake, as influenced by phosphorus availability, concentrations of other parameters, sediment turbidity, zooplankton harvesting, and other factors.

Until more information is available, it will be difficult to develop any program specifically designed to protect the lake. This is because one cannot predict whether a particular action would have significant benefits which would outweigh the costs of the action. However, this does not mean that no protective actions should be taken. Rather, it suggests that watershed protection should emphasize those actions which can be justified on grounds in addition to protection of Lake Thunderbird.

The principal example is that of drainage management and erosion control, which are essential components of any well-designed urban development. New subdivisions must effectively control stormwater runoff and minimize erosion in order to protect the development site and avoid stresses on drainage channels immediately downstream. Many methods are available to accomplish this goal, as discussed in LWA (1982a; section 8 of appendix I). These measures, which include soil protection during construction, site design to retard runoff, construction of detention and siltation ponds, and other techniques, all have the extra benefit of reducing pollutant transport out of the developed area. Consequently, if utilized throughout the Little River basin, such measures should reduce pollutant loadings to Lake Thunderbird, when compared to loadings which would occur without such controls. In order to reduce the impact of increased sedimentation to Lake Thunderbird, EPA conditioned grants for construction of sewage transportation and treatment facilities for the city of Moore, Oklahoma, require certain urban runoff control measures to be taken; EPA would have the option of applying similar conditions to a construction grant to Norman.

Norman recently adopted a drainage ordinance which, in effect, requires developers to satisfy the city that runoff management and erosion control will be accomplished in any new project. If necessary, the developer may be required to make improvements both on and off the development site. The success of such an ordinance can be determined only through experience, and will depend on the actual mix of control measures implemented by developers. Maximum protection to the lake would result if the measures emphasize on-site retention of runoff (rather than efficient conveyance of flow downstream), and if erosion control is obtained without the use of phosphorus-rich fertilization on revegetated areas. Adoption of similar ordinances throughout the watershed, and their full implementation, would be an appropriate step in mitigating the water-quality impacts of urbanization in the Little River basin, and in protecting Lake Thunderbird against potential adverse impacts of nonpoint-source pollution.

It snould be noted that, while point sources are prohibited in the Little River basin above Lake Thunderbird, such sources may occur none-the-less. In the past these have included leaking and overflowing retention ponds, and bypassing of sewage at the Moore treatment plant and Woodcrest lift station. The bypassing problems have been or are in the process of being solved (see LWA, 1982a, section 3 of chapter 5). Attention to the other problems would be an appropriate part of any program to protect the lake.

5.5.7. Administrative Alternatives

Federal regulations for EPA-funded wastewater treatment projects require a sewer-use ordinance prohibiting certain discharges and establishing the requirements for new sewers and connections, and a user charge system and schedule based on flows and wasteloads. These ordinances exist in Norman, but need modification to accommodate the proposed facilities (Baxter, 1982). User charge data will be provided by the facilities plan once an alternative is selected by the city; a preliminary estimate of user charges is presented in section 5.5.8. An industrial cost recovery program is no longer required by the federal government.

The NPDES permit requires development of an Industrial Pretreatment Program, which is now being prepared by the city.

5.5.8 Project Funding

Estimated total direct capital and annual costs which Norman must pay to build a new treatment plant (to level A), expand the collection system, operate the system, and accomplish other necessary wastewater management measures are listed in table 5-8. The figures come from the facilities plan and thus assume codisposal/cogeneration will be selected as the sludge management option. Note that these are not total present worth figures; that is, they do not include interest or inflation costs between now and the time new facilities would actually be constructed. (Refer to appendix B for a more detailed financial breakdown). Annual capital costs range from nearly $1,500,000 to over twice that amount if no federal funding is granted to support facility design and construction. Annual operation and maintenance costs amount to another $1,300,000. These figures are tenative at this time, reflecting the fact that the city has not yet made a final selection among the alternatives.

Monthly residential sewer use fees necessary to cover these costs are also given in table 5-8. Fees would be about $15.00 per month at one-hundred percent local financing, plus whatever fees are necessary to retire existing debts. The figures given below assume EPA funding of potentially eligible facilities, and represent the cost of facilities improvements plus the present monthly charge of about $4.00.

Reliance on sewer use fees is not the only way to retire local revenue bonds. Other methods are possible, such as a sales tax, increased connection

TABLE 5-8. ESTIMATED SEWER USE FEES TO FUND PROPOSED WASTEWATER FACILITIES.

	Amount Funded by Local Bonds	Annual Local Debt Service	Monthly Debt Service per Residence	Monthly Operation & Maintenance per Residence	Average Total Monthly Residential Sewer Use Fee
Maximum	$24,766.000	$3,250,000	$8.46	$ 3.38	$11.84
Minimum	$11,445,000	$1,500,000	$3.90	$ 3.38	$ 7.28

fees, the use of stand-by charges, and the establishment of specific policies towards financing of interceptor extensions. There was some concern expressed in the public participation process that the chosen cost recovery methods assign to those who benefit from new facilities a proportionate share of the costs of those facilities. There are also, however, distributive benefits of new facilities; the alternatives listed below reflect, as a group, both of these classes of benefits.

1. Sales tax. Cities in Oklahoma may generate additional revenue by instituting a local sales tax. Income from this source could be used for retirement of bonds.

2. Connection fees. The charge to hook up to the municipal collection system is $50. Increases in this fee could shift the burden of a new treatment plant and interceptors directly to those who would benefit the most.

3. Stand-by charges. This option would tax vacant properties adjacent to or near a sewer line. This policy encourages infill of vacant land within the existing service area and thus delays or reduces the need for interceptors.

4. Extension policy. Many cities, including Norman, require that developers pay for the extension of interceptors serving their developments. The financial impacts of this policy will depend on the timing and size of these developments and on the way this policy is actually written.

5.6 APPLICANT'S PREFERRED ALTERNATIVE

At this time, Norman has not selected its preferred alternative. However, based on the analyses presented in sections 5.2, 5.3 and 5.4 of this EIS, the following alternatives appear to have the most favorable mix of economic, engineering and environmental benefits, and have been supported in the public participation process.

1. Interceptor construction; lift station improvements; collection system renovations: as described in section 5.2 and summarized in figure 5-2

and table 5-1. Note, however, that the proposal to construct lift station D well to the north of proposed development areas has not been endorsed by the Citizens Advisory Committee; if the proposed lift station is relocated, dollar costs would be reduced by an as yet undetermined amount.

2. Wastewater treatment: as described in section 5.3 and summarized in tables 5-4 and 5-5. The alternatives having the lowest costs also rate best on other evaluation factors, and are likely to be selected. These options are bio-disc treatment for the level A effluent limitations (secondary treatment) and biological nitrification for the level D effluent limitations (advanced treatment).

3. Sludge management: as described in section 5.4 and summarized in tables 5-6 and 5-7. The alternative which appears to rate best overall, anaerobic digestion followed by wet application, is not the lowest cost option. However, based on the analysis in section 5.4, it is the most economic in terms of overall use of resources.

Assuming that the alternatives selected are as identified above, the dollar costs would be as follows (total present worth basis).

Interceptors, etc.:	$ 9,802,404
Treatment to level A standards:	11,561,778
Sludge management:	4,439,783
Total present worth, level A:	$25,803,965
Additional cost of treatment to level D:	20,197,893
Total present worth if level D treatment is required:	$46,001,858

Note that these costs are exclusive of the expense of constructing collection systems in areas of new development.

The complete plant, constructed adjacent to the existing plant, would be capable of treating 10 mgd of effluent in compliance with NPDES permit requirements. Effluent would be discharged to the South Canadian River as at present. Proposed interceptors would provide capacity for 20 years of development to the north and/or east; no additional capacity is proposed for areas south or west of Norman since existing lines have sufficient capacity for 20-year growth. Sludge would be anaerobically digested, followed by land application (wet-injection). The proposed treatment facility utilizes a number of components of the existing facility; these, together with other data on the bio-disc alternative, are listed in appendix B.

The public participation process has indicated that the above alternatives are favored because they appear to be: 1) the most adaptable in the face of changing federal regulations for effluent and sludge disposal; 2) the most flexible in terms of construction and operation especially for near-term solution of NPDES compliance problems; and 3) the least expensive in total resource use.

PART B. ALTERNATIVES AVAILABLE TO EPA

EPA issued the NPDES permit that regulates the discharges from the Norman plant. EPA is responsible for enforcing the permit; enforcement options include letters, administrative orders and referrals to the Department of Justice.

Region 6 of EPA has several options with regard to the funding of the most cost-effective alternative (which may or may not be Norman's preferred alternative).

1. EPA may decide to provide no funds for any Norman project.

2. EPA may fund some percentage of the eligible portions of the project.

3. EPA may attach conditions to any grant awarded.

If Norman is to achieve NPDES compliance and support orderly development in the planning area, the city has no alternative to implementing most of the facilities plan. Thus, EPA's decision would not in itself be expected to change the major impacts of wastewater management actions. Rather, the presence of EPA funding (if any) would substantially reduce the financial burden placed on the residents in the area (as indicated in section 5.5.8). Also, environmental considerations which are part of the EPA grant process (e.g., requirements for archaeological surveys) could increase the prospects for effective mitigation of potential adverse effects.

CHAPTER 6

ENVIRONMENTAL CONSEQUENCES OF ALTERNATIVES

6. ENVIRONMENTAL CONSEQUENCES OF ALTERNATIVES

Chapter 5 characterizes the major environmental impacts of the alternatives. This chapter contains information in support of the impact evaluations. Three types of information are provided: a description of the existing environment; explanations of any of the impact evaluations which are too complex to fully present in chapter 5; and a summary of the beneficial and adverse impacts which could result from different decisions. This chapter contains eight sections. The first seven concern individual environmental components, as follows: earth resources (6.1), water resources (6.2), air and sound quality (6.3), biology (6.4), archaeology and other sensitive resources (6.5), socio-economics and land use (6.6), energy and other resources (6.7). Each of these sections is subdivided and considers, in turn, existing conditions, impacts of the No Action alternative, impacts of collection alternatives, impacts of treatment alternatives, impacts of sludge management alternatives, impacts of other alternatives (e.g., nonpoint-source control), and impacts of EPA alternatives. Section 6.8 summarizes adverse impacts which cannot be avoided, the tradeoff between short- and long-term uses of the environment, and irreversible and irretrievable commitments of resources.

To help make the EIS a concise and useful document, the level of detail is consistent with the decisions which must be made by Norman and EPA, as follows.

- Descriptions of each environmental component are generally brief, with the exceptions of sections 6.2 (water) and 6.6 (socio-economics and land use). These are the principal subjects which bear on prospective decisions.

- The No Action alternative cannot be accepted because it fails to meet mandatory water-quality objectives; therefore impacts of this option are not presented in any detail.

- EPA must fund the lowest monetary-cost alternative that will accomplish the goal of effective wastewater management, unless there are overriding environmental or social considerations. Selection of the best collection and treatment alternatives is based primarily on considerations of cost and engineering reliability rather than on environmental factors. Thus, the subsections on the impacts of collection and treatment alternatives are generally brief. However, where environmental issues are critical to the decision they are explained in detail. Likewise, many of the remaining components of the wastewater system will be selected on economic or engineering grounds; environmental information is provided only where environmental considerations might override monetary considerations.

- The main decision facing EPA is the approval/funding of specific collection and treatment alternatives. The impacts of these decisions are as described in the specific sections on the alternatives and are not repeated in detail in the section on agency alternatives.

6.1 EARTH RESOURCES

Earth resources include natural regions (terrain), climate, geology and soils.

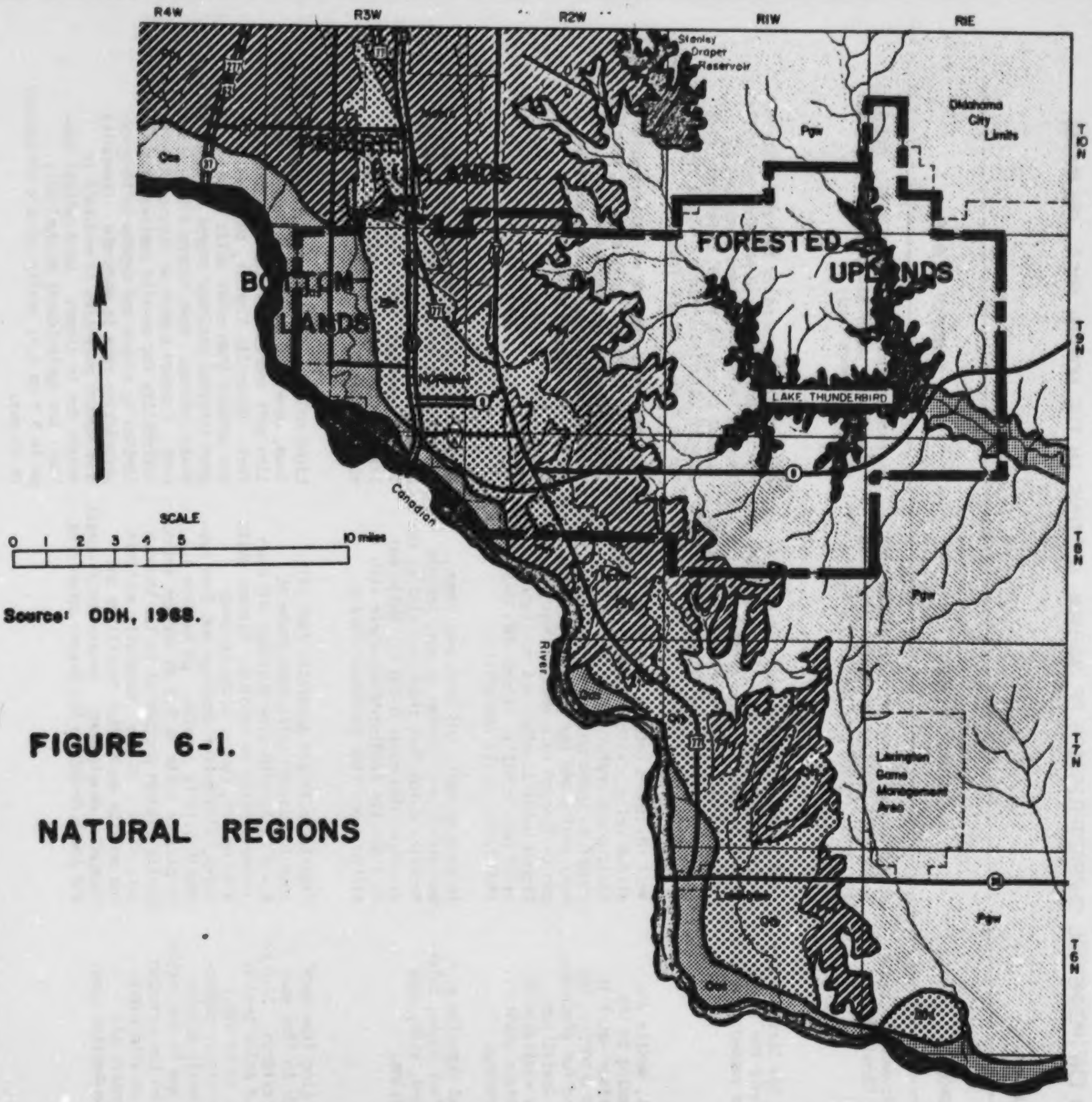
6.1.1 Existing Conditions

Natural regions. The landscape of Norman can be divided into three natural regions, each having distinctive environmental characteristics. The distribution of the three natural regions is shown in figure 6-1. Characteristics of the units are given in table 6-1. The table and figure summarize much information regarding the physical and biological environment of the Norman area and will be referred to throughout the EIS.

Bottomlands include the river flood plains and adjacent low terraces along the Canadian and Little Rivers. Prairie Uplands are the rolling grasslands of the western part of the area; they include high river terraces and areas underlain by shale bedrock. Forested Uplands include the more hilly terrain which occurs in the eastern half of the planning area, and which makes up most of the Little River basin. Where clearing has not occurred, this unit has a native vegetative cover of shrub forest (where bedrock is sandstone) and grassland (where bedrock is shale).

Climate. The temperature regime in Norman exhibits a wide annual range, with 65 days per year over 90° F and 80 days under 32° F. The growing season averages 220 days per year, or over seven months. Insolation totals about 156 langleys per year, with the sun showing 67 percent of the possible time. These are high values compared to non-southwestern locations, and indicate a potential for use of solar energy. Precipitation averages about 34 inches a year, mostly as spring and summer thunderstorms. Thunderstorms occur on an average of 50 days per year. Average snowfall is less than 10 inches per year and seldom stays on the ground long. Free-water evaporation (which is roughly equivalent to consumptive use by plants) exceeds precipitation, making wastewater irrigation and evapotranspiration systems technically feasible. Prevailing winds are from the south except in December, January and February, when they are from the north (Buckhannon, 1954).

Geology. Four geologic units are important in the Norman area (Wood and Burton, 1968; Bingham and Moore, 1975). The oldest rocks include the closely related Garber and Wellington Formations, which contain important water-bearing sandstone beds alternating with shale. The Garber-Wellington is exposed along a 10-20 mile wide north-south trending band on the east side of Cleveland County; it dips westward at about 30-40 feet per mile beneath rocks of the Hennessey Group, which are dominantly shale and which occur on or within 100 feet of the surface in most of the urbanized portion of Norman, including the Bishop Creek service area. Both the Garber-Wellington and the Hennessey are marked by great variability due to the interfingering of sandy, silty and/or shale lenses which seldom continue over long distances. Capping the two bedrock units in many places are unconsolidated river terrace deposits and stream alluvium, both consisting of lenses of sand, silt, clay and gravel.



R4W
R3W
R2W
R1W
R1E
Stanley Draper Reservoir
Oklahoma City Limits
T10N
T9N
T8N
T7N
T6N
PRAIRIE UPLANDS
BOTTOM LANDS
FORESTED UPLANDS
LAKE THUNDERBIRD
Canadian River
Norman
Lexington Game Management Area
Pgw
Qal
N
SCALE
0 1 2 3 4 5 10 miles

Source: ODH, 1968.

FIGURE 6-1.

NATURAL REGIONS

NATURAL REGIONS		GEOLOGY	SOILS	VEGETATION
Bottomlands	▩	Alluvium	McLain, Reinach, Yahola, Pulaski	Pastureland
Prairie Uplands				
Terraces	▨	Terrace deposits	Vanoss, Minco, Norge	Grassland
Prairie	▦	Hennessey Group (shale)	Bethany, Renfrew, Kirkland	Grassland
Forested Uplands	▧	Garber-Wellington Unit (sandstone)	Stephenville	Oak-Hickory Forest

TABLE 6-1. GENERALIZED ENVIRONMENTAL CHARACTERISTICS OF NATURAL REGIONS IN THE NORMAN AREA, OKLAHOMA.

Refer to Figure 6-1 for location of areas.

ENVIRONMENTAL CHARACTERISTIC	BOTTOMLANDS	PRAIRIE UPLANDS	FORESTED UPLANDS
Location & Subunits	Along or near major streams; includes two subunits: stream flood plains; adjacent low terraces.	Western and highest portion of planning area; includes two subunits: high, old terraces; upland prairie over shale.	Eastern portion of planning area. Alluvial valleys also occur along streambeds; refer to "Bottomlands" unit.
Terrain	Generally level land; low terraces lie at least a few feet above the flood plains. Slopes seldom exceed 2 percent.	Gently rolling plain; terraces are slightly dissected with slopes of less than 5 percent; uplands a bit more dissected with slopes generally less than 10 percent. Local relief varies from 20 to 150 feet.	Rolling plain and hilly terrain. Slopes are commonly from 5-10 percent, but hills tend to be steeper sided where cut by streams occupying broad, relatively flat floored alluvial valleys. Local relief varies from 50 to 200 feet.
Drainage; hydrology	Cut crosswise by short, mostly intermittant streams heading in the adjacent uplands. Surface water is generally available in quantity, but seldom used due to need for diversion, storage and treatment facilities. Ground water generally available at shallow depths in moderate quantity. Unit is subject to flooding.	Well developed network of shallow stream valleys with dendritic drainage. Small ponds capture sheet and stream runoff in upper portion of many valleys. Many swales and low spots exist which can be flooded to a shallow depth. Ground water is often not available or of poor quality, except when deep (500 feet+) wells are drilled.	Well developed network of valleys with dendritic drainage; gullies occur locally. Ground water is generally available at shallow depths in moderate quantities, and locally discharged at springs.
Geology	Unconsolidated alluvial deposits of Quaternary age, 0-70 feet thick; interfingering lenses of sand, silt, clay and gravel in flood plains.	Terrace deposits and Hennessey Group, Quaternary and Permian in age; terrace deposits 0-100 feet thick and similar to alluvium; Hennessey 0-100 ft. thick and is a massive reddish-brown shale with siltsone and fine sandstone layers.	Garber-Wellington formations of Permian 800-1000 feet thick; reddish to orange-brown massive cross-bedded, fine-grained, loosely cemented, lenticular sandstone irregularly interbedded with silty or sandy shales.
Soils	Alluvial materials ranging from sand and clay on bottomlands to fine sand or silt loams on low terraces. Texture is highly variable, and soils tend to be deep. Runoff tends to be slow; drainage moderate. Generally calcareous; pH 7.0 - 7.6. Easily soluble phosphorus is 22 - 60 ppm in the Little River basin; 80 - 103 on the Canadian side. Unsuitable for on-site wastewater facilities and nearly all non-agricultural or non-habitat uses.	Prairie soils are generally fine silt loam to claypan soils over shale at 6 - 8 feet, with slow drainage and high susceptibility to erosion. Terrace soils are coarser, deeper silty to sandy loams, with better drainage and less susceptibility to erosion. pH is from 6.4 on prairie soils to 7.2 on terrace soils. Easily soluble phosphorus is low throughout, at 16 - 30 ppm. Generally suitable for on-site wastewater facilities and community development. Severe shrink-swell and low strength in the Norman urban area.	Light colored, friable, acid, fine sandy loam, developed under scrub forest, overlies soft reddish sandstone at about 3 feet. Generally lighter, shallower and sandier than other soils in area, with good internal drainage except in areas of shale outcrop. Most slopes are 4-12 percent. Erosion common on steeper slopes. Suitability for on-site wastewater systems limited by slopes and depths to bedrock; percolation rate is moderate. Community development potential is moderate to severe due to slopes. Good natural habitat, low agricultural productivity. pH is 5.3 to 6.7; easily soluble phosphorus is 10 ppm.

TABLE 6-1. Continued

ENVIRONMENTAL CHARACTERISTIC	BOTTOMLANDS	PRAIRIE UPLANDS	FORESTED UPLANDS
Biology	Vegetation: bur oak, hackberry, elm, black walnut, pecan, eastern cottonwood, willow, sycamore, wild grape. Undergrowth of bluestems, Johnson grass, Bermuda grass, Canadian wild-eye. Mammals: bats, nine-banded armadillo, beaver, plains harvest mouse, white-footed mouse, wood rat, coyote, bobcat, white-tailed deer, striped skunk. Birds: marsh hawk, yellow-billed cuckoo, roadrunner, chuck-will's widow, common nighthawk, flicker, eastern phoebe, bluejays, brown creeper, winter wren, caroline wren, mocking-bird, white-eyed vireo, prothonota warbler, orange-crowned warbler, rose-breasted grosbeak, white crowned sparrow, song sparrow. Amphibians: small mouthed salamander, grey tree frog. Reptiles: copperhead, ringneck snake, eastern hognose, common kingsnake, coachwhip, rough greensnake, box turtle, five-lined skink, ground skink.	Vegetation-undisturbed: tallgrass prairie; little bluestem, big bluestem, side-oats grama, buffalograss, hairy grama, silver beardgrass, dropseed. Vegetation-disturbed: prairie three-awn, dropseed, little barley, bromegrass, six weeks fescue, red lomegrass, fall witchgrass, hairy triodia, hairy crabgrass. Mammals: least shrew, eastern mole, cottontail, thirteen-lined ground squirrel, plains pocket gopher, brush mouse, fulvous harvest mouse, cottonrat, coyote, gray fox, raccoon, striped skunk. Birds: Red-tailed hawk, Swainson's hawk, marsh hawk, roughlegged hawk, turkey vulture, bobwhite quail, wild turkey, morning dove, roadrunner, great horned owl, night hawk, fly-catchers, eastern kingbird, western kingbird, scissor-tailed flycatcher, horned lark, loggerhead shrike, prairie warbler, bobolink, western meadowlark, red-winged blackbird, vesper sparrow, field sparrow, Le Conte's sparrow. Amphibians: hunters spadefoot toad, great plains toad, rocky mountain toad, spotted chorus frog, tiger salamander. Reptiles: box turtle, horned lizard, racer, corn snake, bullsnake, prairie kingsnake.	Vegetation - undisturbed: blackjack oak, post oak, hickory red oak, persimmon; open stands of mature trees with grass ground cover. Vegetation - disturbed: post oak-blackjack woodlands; dense scrubby oak growth, winged sumach, smooth sumach, brickbrush, green brias, other shrubs and vines. Mammals: bats, oppossum, raccoon, pine vole, gray fox, fox squirrel, eastern cottontails, white-tailed deer. Birds: screech owl, great horned owl, woodpeckers, flycatchers, crows, jays, verdins, nuthatches, wrens, thrushes, gnatcatchers, vireos, warblers, indigo bunting, purple finch, American goldfinch, fox sparrow. Amphibians: American toad, chorus frog, cricket frog, tiger salamander, bullfrog, leopard frog are ubiquitous in habitat preference. Reptiles: box turtle, ground skink, copperhead, timber rattlesnake, ringneck, eastern hognose, rough earthsnake.
Land Use	Some agriculture in low terraces. Elsewhere mostly natural habitat in floodplain; rangeland and pasture on low terraces unsuitable for most other uses due to flood hazards.	Terraces are relatively prime land for agricultural crops. Range and urban uses currently dominate.	Rangelands and recreational uses are most common; with increasing development in large-lot rural subdivisions.

Sources: Wade, 1964; Soil Survey Series, 1942; Adams and Risser, 1973.

These relatively young sediments are most abundant within the Canadian River drainage but also occur in the Little River Basin. Figure 6-1 shows the surface distribution of the units. For additional information refer to Wood and Burton (1968); Bingham and Moore (1975); and Wickersham (1979).

Cleveland County is relatively stable seismically and otherwise generally free from geologic hazards. Important geologic resources include oil and gas reserves tapped by wells throughout the county, and some sand and gravel extraction from pits in the terrace and alluvial materials. No important paleontological sites are known to occur, but the outcrop area of the Garber-Wellington is well known for its mineral specimens of "sand roses" or sand-barite crystals.

Soils. A description of soils in relation to natural units and physical characteristics is given in table 6-1 and figure 6-1. Generally soils of the bottomlands are sandy or silty loams, susceptable to flooding, and are used largely for pasture land. Prairie soils are deeper and heavier, and suitable for most uses; principal uses are agriculture and urban development. Forest soils to the east are thinner, lighter, often sandy, and used for forest land, watershed, recreation and grazing.

Table 6-1 includes suitability of the various soils for use with on-site wastewater systems (OSS). The table indicates that Bottomland soils, as mostly found on the west side of the planning area, are generally unsuitable, usually due to seasonal high water table. Prairie Uplands soils vary but are generally suitable; most of this area is sewered. The Forested Uplands (Little River basin area) generally have soils of moderate percolation rate, though slope and bedrock are problems for OSS locally; again, alluvial soils in this area have higher water tables.

Of special interest in terms of soils are nutrient levels, which may impact surface-water quality through runoff. Table 6-1 summarizes soil nutrient conditions in the Norman area for nitrogen, phosphorus, and ESP (readily soluble phosphorus). Bottomland soils are high in ESP; ranging from 22 parts per million (ppm) to 60 ppm in the Little River basin and from 80 ppm to over 100 ppm in the Canadian River basin. Prairie Upland soils (e.g., the Norman urban area) are mostly under 30 ppm in ESP. Forested Uplands soils (nearly half of the Little River basin) are only 8 ppm.

6.1.2 Impacts of the No Action Alternative

There are no impacts to terrain, climate, geology or soils under the No Action alternative, except that this alternative would not serve to direct growth away from the most suitable agricultural lands, as would the preferred alternative.

6.1.3 Impacts of Collection Alternatives

The collection system alternatives all lead to adverse short-term construction impacts. These impacts, and appropriate mitigation measures, are summarized in section 5.2.3. Erosion would generally be a minor problem at most sewer construction sites because of gentle natural slopes; it may be a greater problem where lines lie in or cross a waterway, due to storm runoff. The major risk would occur on banks that may be disturbed by construction equipment either to lay the line itself or to gain access to the stream bed. Adverse impacts can be avoided by: 1) minimizing activities which disturb stream banks; 2) stabilizing bank cuts through structural measures such as riprap or concrete sheet piling. It may be necessary to use excavated soil to build small temporary structures for diverting flows around a site and/or for collection and desilting of flows from a site. After construction it is conventional practice to grade a slight mound along any line which is not in a street right-of-way. This provides positive drainage away from the bare area, and reduces the potential for erosion.

Construction activities would not be expected to lead to any significant long-term alterations in the landscape, or to a change in the character of a natural drainageway. Refer to DWR (1972) and EPA (1973) for further information on erosion control planning; see also table 5-3 for specific mitigation measures.

6.1.4 Impacts of Treatment Alternatives

Most treatment alternatives have minimal effects on earth resources, consisting of short-term construction impacts which would occur within the existing plant site. These impacts are described in section 5.2.3 (see especially table 5-2). Substantially greater impacts of the same type would result from alternatives which involve either: a) a new plant site; or b) significant expansion of the existing site. Such options were eliminated in the initial screening (see section 5.3.3).

6.1.5 Impacts of Sludge Management Alternatives

All four of the sludge disposal alternatives require some land. Alternatives 1 and 2 require from 205 acres (level A) to 687 acres (level D) for land application of sludge. At level D, an additional 60 acres would be required for disposal of chemical sludge. Potential wind erosion from vegetation removal and mechanical disturbance of the soil would be minimized by the annual rainfall of 34 inches per year and by the fact that sludge applications would increase soil moisture, lead to greater soil aggregation, and result in a rougher soil surface (which reduces wind efficiency). However, especially after the soil dries out each year, it might be that some additional control measures (such as a windbreak) would be needed to minimize erosion problems. Such measures can be developed during detailed design of the facilities or as needed after the site is established.

As discussed in section 5.4, sludge is a good soil conditioner and has some fertilizer value. Therefore, sludge application should have a positive impact on the soil, such as improving its texture, water-retention, and ion-exchange properties. However, there is some possibility that heavy metals (especially cadmium) from the sludge might build up to levels that are toxic either to plants or to the higher food chain. For this reason, EPA regulations (40 CFR 257) require that the disposal area not be used in the future for growing food-chain crops. Heavy metal content in sludge varies according to the industries discharging to the treatment plant. Since Norman has little industry, heavy metal buildup may not be a problem. The facilities plan includes calculations that indicate cadmium levels will not build to unacceptable levels with the proposed application rate. Depending on regulatory policies, the fertility of the site may be put to beneficial use at some future time. Alternatively, the sludge/soil mixture could be mined and used as a soil conditioner (on city parks, or through sale to the public).

The codisposal and incineration alternatives call for use of 4 to 20 acres over the 20-year planning period for ash disposal. With level D treatment, an additional 60 acres would be required for disposal of chemical sludge. Unavoidable, long-term impacts which would result from this practice are those associated with a normal landfill operation.

6.1.6 Impacts of Other Alternatives

For the most part, actions taken with respect to on-site systems, disinfection, energy conservation, odor control, water conservation, administration, and funding have no impacts on earth resources. Alternatives for control of nonpoint sources, discussed in section 5.5.6, include control of soil erosion.

6.1.7 Impacts of EPA Alternatives

The major impacts on earth resources are adverse, short-term effects resulting from construction of interceptors, improvements at the treatment plant, and use of a sludge application site. These effects are an unavoidable result of the actions which Norman must take, if it is to correct existing treatment deficiencies and provide for orderly urban development. EPA alternatives do not alter these impacts, except that the normal funding process provides an added level of review which helps ensure that mitigation measures, such as those listed in table 5-3, are considered for inclusion in construction contracts.

6.2 WATER RESOURCES

Water is a resource in a number of different ways. It is used for drinking, for industry (e.g. cooling water), and for irrigation. Water bodies provide important biological habitat, and also provide recreation and aesthetic pleasure.

The discussion in this section considers water in a number of different aspects. There is a distinction between water quantity -- the amount of water available for a given purpose -- versus water quality -- the suitability of that water for the use. The impact of a given action will generally have separate impacts on the quantity and quality of surface water (streams, rivers, lakes) versus ground water (water stored in geologic formations beneath the surface).

The primary surface waters of importance in Norman are the South Canadian River and the Little River basin, which includes Lake Thunderbird. There is also an important ground water system underlying Norman. Thus, impacts of the wastewater facilities are considered in light of their effects on these water bodies. Also considered in this section are flood hazards and water supply.

6.2.1 Existing Conditions: Surface Water Quantity

Little River basin. The Little River is a tributary of the Canadian River, which it joins near Holdenville some 60 miles east-southeast of Norman (figure 3-1). The basin contains 973 square miles, of which 256 square miles are above the Lake Thunderbird dam site. In conjunction with the EIS, a survey has been performed to compile the water-resources data available for the watershed and lake, and to assess how water quality may change in response to urban development in the basin. The results of the study are provided in a separate report (LWA, 1982a), which is the source of most water resources information presented in this EIS.

Figure 3-2 outlines the upper portion of the watershed, which will be termed the Little River basin in this EIS. Figure 3-2 shows major hydrologic features (reservoirs, tributaries) and political boundaries. The major impoundment upstream of Lake Thunderbird is Lake Stanley Draper. Several hundred smaller ponds occur on tributary streams within the basin. It appears that Lake Draper and the ponds control runoff from about 40 percent of the entire Little River basin above Lake Thunderbird.

Lake Thunderbird reservoir was completed in 1965 as a municipal water-supply source for Norman, Midwest City and Del City. Under full development, 21,600 acre-feet per year (AFY) of water would be pumped to the three cities. Currently pumping is less than 10,000 AFY. As the site of Little River State Park, the lake provides recreation benefits to about two million visitors per year; it also stores flood waters to protect downstream areas.

The lake effectively reached capacity in 1970 and has averaged 90-100 percent full. Runoff to the reservoir was expected to average about 56,000 AFY. A detailed water budget shows that actual runoff has been substantially less, averaging 34,500 AFY from March, 1965 through August, 1977 (LWA, 1982a). The low runoff appears to reflect several factors, especially: drought conditions during the period in question; probable errors in the original estimates; and effects of upstream impoundments. Based on the water budget, the inflow from an average year would remain in the reservoir about 32 months before being depleted by pumping, flood releases, seepage, and evaporation. A volume of water equivalent to the capacity of the lake is removed by evaporation every five years.

Extensive gaging station records are available for the Tecumseh and Sasakwa gages in the Little River below Lake Thunderbird. These records indicate that since Lake Thunderbird was built, streamflows have become more even (fewer floods, virtual elimination of zero-flow conditions), and that total runoff has declined by about 30 to 40 percent. The decline of flow is more than would be accounted for by evaporation losses and pumping from Lake Thunderbird.

Canadian basin. Most of the Norman urban area is drained by small tributaries to the South Canadian River (figure 4-1). There are no data on flows in these sub-basins, but based on general observations in central Oklahoma the natural (pre-development) flow would be likely to be about four inches per year. As the basins are now substantially urbanized, the current discharge is greater, perhaps by a factor of two. The Canadian, itself, has an extremely variable flow which averages 290,000 acre-feet per year.

Flood hazards. Norman participates in the National Flood Insurance Program and is in the regular phase of the program. A Flood Insurance Rate Study has been conducted by the Corps of Engineers and a final map of flood rate insurance zones prepared. The city of Norman has adopted zoning ordinances, subdivision regulations, and building permit requirements as part of its program to reduce the losses caused by flooding and to ensure proper land use in the flood plains. Figures 6-2 through 6-5 define the 100-year flood plains for that part of the planning area affected by the facilities plan. Neither the existing treatment plant nor any of the lift stations are within flood hazard areas identified on the map. Several sections of the existing interceptor network follow the major drainages and are in an 100-year flood plain.

The Canadian River has three major flood control structures located above Norman, but because of the large drainage area between the reservoirs and Norman, the amount of flood reduction in the study area is minor. The recorded peak flow for the Canadian River was 200,000 cubic feet per second in 1939.

Flooding in the Norman area usually results from intense rainfalls during local thunderstorms (HUD, 1979). Peak discharges are typically a few hundred to a few thousand cubic-feet per second per square mile of drainage area (decreasing with increasing basin size). Urbanization increases peak discharge by two to threefold. Portions of Imhoff and Normandy (Merckle) Creek have been channelized. Flooding will be significantly reduced on Imhoff Creek between Oklahoma Highway 9 and Lindsey Street because of the channel improvement. The majority of the 100- and 500-year flood water will stay within the banks of Imhoff Creek along this portion of the stream. The channelization along Merckle Creek (between Lindsey Street and Interstate Highway 35) will not significantly reduce the flooding on that stream (HUD, 1979).

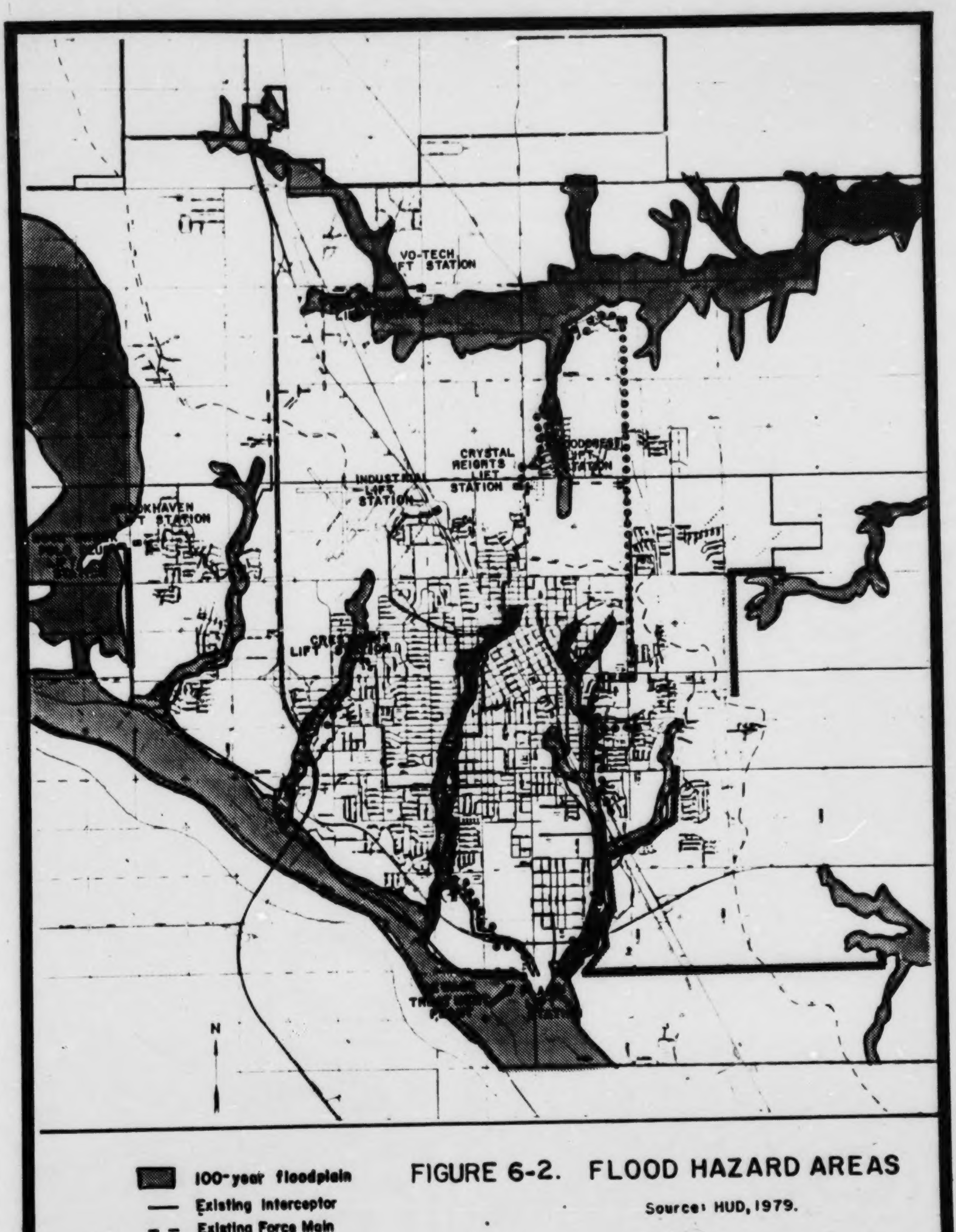
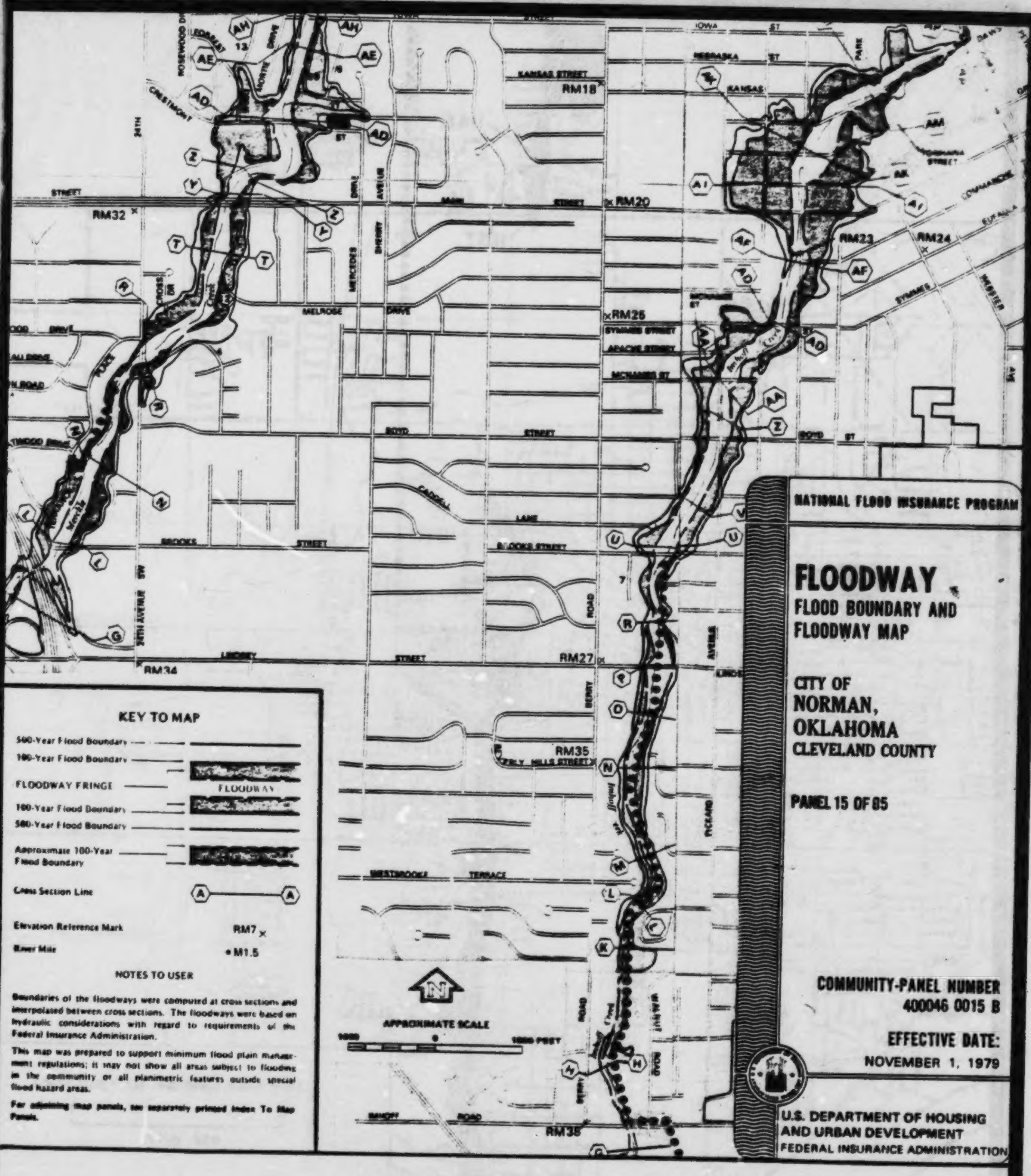

VO-TECH LIFT STATION
CRYSTAL HEIGHTS LIFT STATION
WOODCREST LIFT STATION
INDUSTRIAL LIFT STATION
BROOKHAVEN LIFT STATION
CRESTMONT LIFT STATION
N
▨ 100-year floodplain
— Existing Interceptor
– – Existing Force Main
■ Lift Station
●●●● Initial line construction
Future line construction

FIGURE 6-2. FLOOD HAZARD AREAS

Source: HUD, 1979.


NATIONAL FLOOD INSURANCE PROGRAM
FLOODWAY
FLOOD BOUNDARY AND FLOODWAY MAP
CITY OF NORMAN, OKLAHOMA
CLEVELAND COUNTY
PANEL 15 OF 85
COMMUNITY-PANEL NUMBER
400046 0015 B
EFFECTIVE DATE:
NOVEMBER 1, 1979
U.S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
FEDERAL INSURANCE ADMINISTRATION
KEY TO MAP
500-Year Flood Boundary
100-Year Flood Boundary
FLOODWAY FRINGE
FLOODWAY
100-Year Flood Boundary
500-Year Flood Boundary
Approximate 100-Year Flood Boundary
Cross Section Line
Elevation Reference Mark
RM7
River Mile
M1.5
APPROXIMATE SCALE
1000
0
1000 FEET
IOWA ST
NEBRASKA ST
KANSAS STREET
KANSAS
MAIN STREET
MELROSE DRIVE
BOYD STREET
BOYD ST
CADDELL LANE
BROOKS STREET
LINDSEY STREET
SYMMES STREET
APACHE STREET
MCNAMEE ST
COMMERCE
EUFAULA
WESTBROOKE TERRACE
IMHOFF ROAD
BEVERLY HILLS STREET
24TH AVENUE SW
CRESTMONT
MERCEDES
CHERRY AVENUE
BERRY ROAD
WALNUT ROAD
PICKARD
RM18
RM20
RM23
RM24
RM25
RM27
RM32
RM34
RM35
RM36
Imhoff Creek
Bishop Creek

NOTES TO USER

Boundaries of the floodways were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the Federal Insurance Administration.

This map was prepared to support minimum flood plain management regulations; it may not show all areas subject to flooding in the community or all planimetric features outside special flood hazard areas.

For adjoining map panels, see separately printed Index To Map Panels.

▬ Lift Station

●●●●●●●● Initial line construction

FIGURE 6-3. ROUTE OF PROPOSED BASIN A & B INTERCEPTORS

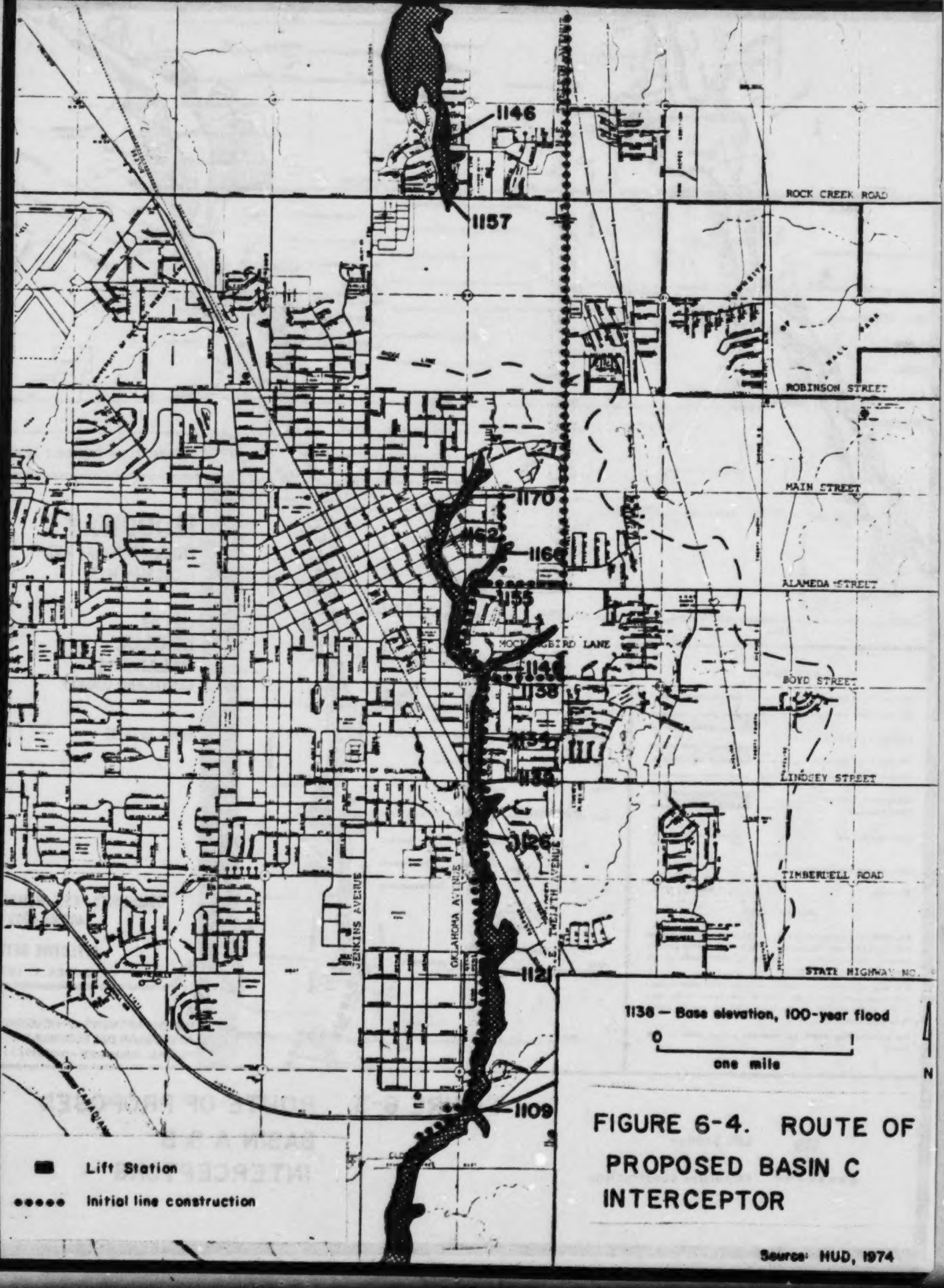
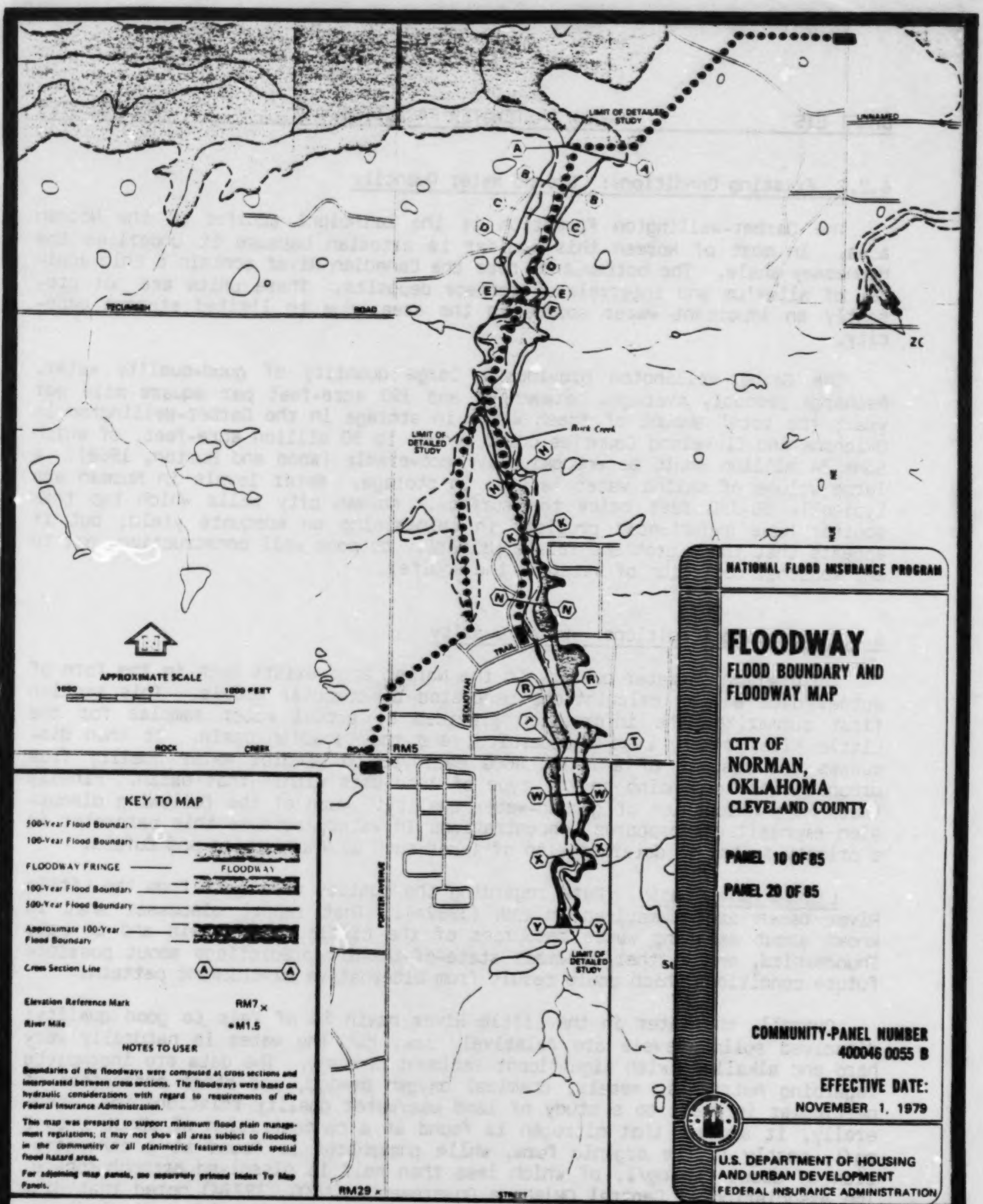

1146
1157
ROCK CREEK ROAD
ROBINSON STREET
MAIN STREET
1170
1162
1160
ALAMEDA STREET
1155
MOCKINGBIRD LANE
1146
1138
BOYD STREET
1134
LINDSEY STREET
1126
TIMBERDELL ROAD
JENKINS AVENUE
OKLAHOMA AVENUE
E. TWELFTH AVENUE
STATE HIGHWAY NO.
1121
1109
1138 — Base elevation, 100-year flood
0
one mile
N
Lift Station
Initial line construction

FIGURE 6-4. ROUTE OF PROPOSED BASIN C INTERCEPTOR

Source: HUD, 1974


LIMIT OF DETAILED STUDY
UNNAMED
TECUMSEH
ROAD
Rock Creek
TRAIL
SEQUOYAH
ROCK
CREEK
ROAD
RM5
PORTER AVENUE
RM29
STREET
APPROXIMATE SCALE
1000
0
1000 FEET
KEY TO MAP
500-Year Flood Boundary
100-Year Flood Boundary
FLOODWAY FRINGE
FLOODWAY
100-Year Flood Boundary
500-Year Flood Boundary
Approximate 100-Year Flood Boundary
Cross Section Line
Elevation Reference Mark
RM7
River Mile
M1.5
NOTES TO USER
Boundaries of the floodways were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the Federal Insurance Administration.
This map was prepared to support minimum flood plain management regulations; it may not show all areas subject to flooding in the community or all planimetric features outside special flood hazard areas.
For adjoining map panels, see separately printed Index To Map Panels.
NATIONAL FLOOD INSURANCE PROGRAM
FLOODWAY
FLOOD BOUNDARY AND FLOODWAY MAP
CITY OF NORMAN, OKLAHOMA CLEVELAND COUNTY
PANEL 10 OF 85
PANEL 20 OF 85
COMMUNITY-PANEL NUMBER 400046 0055 B
EFFECTIVE DATE: NOVEMBER 1, 1979
U.S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
FEDERAL INSURANCE ADMINISTRATION

▬	Lift Station
●●●●●●	Initial line Construction

FIGURE 6-5. ROUTE OF PROPOSED BASIN D INTERCEPTOR

6.2.2 Existing Conditions: Ground Water Quantity

The Garber-Wellington Formation is the principal aquifer of the Norman area. In most of Norman this aquifer is artesian because it underlies the Hennessey shale. The bottomlands near the Canadian River contain a thin aquifer of alluvium and interrelated terrace deposits. These units are not presently an important water source in the area, due to limited storage capacity.

The Garber-Wellington provides a large quantity of good-quality water. Recharge probably averages between 90 and 190 acre-feet per square mile per year; the total amount of fresh water in storage in the Garber-Wellington in Oklahoma and Cleveland Counties could amount to 50 million acre-feet, of which some 34 million would be economically recoverable (Wood and Burton, 1968). A large volume of saline water is also in storage. Water levels in Norman are typically 50-350 feet below the surface. Norman city wells which tap this aquifer have experienced problems in maintaining an adequate yield, but it appears that these problems relate primarily to poor well construction, not to any regional depletion of water in the aquifer.

6.2.3 Existing Conditions: Water Quality

Information on water quality in the Norman area exists both in the form of actual data and as calculations generated by computer models. This section first summarizes the information provided by actual water samples for the Little River basin, Lake Thunderbird, and the Canadian basin. It then discusses the results of a model ACOG employed to predict water quality from urban basins, depending on the type of land uses within that basin. Finally there is a discussion of ground-water quality. Much of the following discussion emphasizes phosphorus concentrations in water, because this parameter is a primary factor in deterioration of lakes such as Thunderbird and Eufala.

Little River basin. Data regarding the quality of runoff from the Little River basin are summarized in LWA (1982a). That report discusses what is known about existing water resources of the Little River basin and in Lake Thunderbird, and further provides state-of-the-art predictions about possible future conditions which could result from alternative development patterns.

Overall, the water in the Little River basin is of fair to good quality; dissolved solids levels are relatively low, but the water is naturally very hard and alkaline, with significant sediment content. The data are incomplete regarding nutrients, metals, chemical oxygen demand, and other parameters of particular interest to a study of land use/water quality relationships. Generally, it appears that nitrogen is found at a concentration of about 1 to 2 mg/l, mostly in the organic form, while phosphorus is found at a concentration of about 0.2 mg/l, of which less than half is dissolved orthophosphate. The Association of Central Oklahoma Governments (ACOG, 1977d) noted that dissolved oxygen levels generally exceeded 5 mg/l, averaging 8-9 mg/l; however, data from the Hog Creek inlet of Lake Thunderbird indicate some instances of oxygen depletion within the basin.

The data summarized in LWA (1982a) provide some insight regarding variations in water quality in different parts of the basin. The patterns which are apparent include:

- alkalinity appears to be much lower in urban runoff than in rural runoff, while nitrogen, phosphorus, and chemical oxygen demand levels are much higher;
- nitrate appears to be virtually absent in runoff from the eastern part of the basin;
- phosphorus levels are much higher in the Little River than in other streams which flow into Lake Thunderbird.

Oklahoma has developed a water quality management plan for the Little River above Thunderbird Dam (segment 520810; ODPC, 1979a). Based on samples taken at a station immediately below the dam, the segment is classified as Water Quality Limited for dissolved oxygen, temperature, manganese, iron, and silver. "Water Quality Limited" implies that violations of stream standards have occurred for the listed parameters (except dissolved oxygen, which is included due to inadequate monitoring data). This segment is classified as "poor" in regard to nutrients, and is classified as "fair to poor" in regard to minerals. Analysis of nonpoint sources within this segment found the following:

- roadside erosion is moderate;
- excessive sediment loadings to Lake Thunderbird are occurring due to highly erodible soils in the watershed and along the shore, roadside erosion, and urban development in the watershed;
- fertilizer and insecticide usage are low; herbicide usage is moderate.

Lake Thunderbird. Water quality within Lake Thunderbird has been evaluated in a large number of studies. The available data are summarized in LWA (1982a). Tables 6-2 and 6-3 provide a simple listing of basic data, and indicate that, at present, the quality of the reservoir is generally good. Lake Thunderbird water is hard and alkaline, but not excessively so. Turbidity levels are high. Iron and manganese often exceed drinking water standards (but note that the standards are set according to considerations of aesthetics, not health). A small amount of (possibly invalid) data suggests that lead levels are near the limit set for drinking water. Levels of all constituents are higher in the lake inflow (Little River inlet) than in the main body near the dam. Turbidity and manganese increase with increasing depth in the lake, while dissolved oxygen, alkalinity, hardness, and iron decrease. Seasonal data show that dissolved oxygen levels are lowest in the summer and highest in the winter; phosphate levels are highest in summer. It is difficult to pick out any long-term trends in Lake Thunderbird water quality, except that nitrogen levels appear to have increased over time.

TABLE 6-2. WATER QUALITY OF LAKE THUNDERBIRD NEAR THE DAM.

lt = less than. mg/l = milligrams per liter. ml = milliliter. $CaCO_3$ = calcium carbonate. JTU = Jackson turbidity units. N = nitrogen. P = phosphorus.

	General [a]		Spacial: depth in feet [b]					Seasonal [c]				Temporal [d]					
Parameter	Range	Mean	1-5	10-15	20	30	40	Spring	Summer	Winter	Fall	1973	1974	1975	1976	1977	1979
Alkalinity, mg/l as $CaCO_3$	137-225	175	183	182	-	180	180	171	173	174	186	-	176	178	171	173	149
Ammonia, mg/l as N	0.04-0.98	0.18	0.03	0.04	-	0.04	0.04	0.2	lt 0.1	lt 0.1	lt 0.1	-	lt 0.1	lt 0.2	lt 0.2	lt 0.2	0.93
Chloride, mg/l	11-84	30	21	22	21	21	20	30	29	28	38	21	25	37	47	28	-
Coliforms, no./100 ml	0-1000	260	260	50	-	-	-	-	-	-	-	260	-	-	-	-	-
Dissolved oxygen, mg/l	3.0-13.0	8.1	8.5	8.3	-	8.3	8.0	9.1	4.2	11.8	10.8	6.4	9.6	10.8	-	7.3	-
Hardness, mg/l as $CaCO_3$	124-226	199	154	142	142	139	136	189	188	185	202	154	195	193	187	184	-
Iron, mg/l	0.02-4.5	1.2	1.2	1.7	0.3	0.4	0.4	-	-	-	-	1.2	-	-	-	-	-
Lead, mg/l	0.03-0.05	0.04	-	-	-	-	-	-	-	-	-	0.04	-	-	-	-	-
Manganese, mg/l	0-1.73	0.7	0.7	0.7	0.7	1.8	3.5	-	-	-	-	0.7	-	-	-	-	-
Kjeldahl nitrogen, mg/l as N	0.1-3.7	1.0	0.6	0.5	-	0.5	0.5	1.2	1.3	0.8	1.7	-	1.1	1.5	1.2	1.2	0.38
Nitrate + nitrite, mg/l as N	0-0.87	0.22	0.13	0.13	-	0.13	0.13	0.2	lt 0.2	lt 0.2	lt 0.2	.24	.24	.21	.20	lt .1	0.23
pH	6.8-8.8	8.2	8.37	8.34	-	8.34	8.30	8.2	8.1	8.3	8.0	8.4	8.0	8.1	8.3	8.2	-
Phosphorus, total, mg/l as P	0.003-0.610	0.049	0.025	0.026	-	0.026	0.033	0.028	0.043	0.025	0.025	-	.03	.03	-	0.06	0.06
Turbidity, JTU	1-35	11	16	20	23	29	-	10	9	3	10	16	7.8	11.3	-	-	9.6

a. Condensed from several sources, covering years 1967 to 1976. Some anomalously high data excluded. References: Roach, 1974; Canter, 1973; OSDH (STORET data); USGS, 1976; EPA, 1977a.
b. From EPA, 1977a and Canter, 1973.
c. From OSDH (STORET data) and EPA, 1977a. Spring = April - June; Summer = July - September; Fall = October - December; Winter = January - March.
d. From OSDH, except 1973, which is from Canter, 1973.

TABLE 6-3. WATER QUALITY OF LAKE THUNDERBIRD, LITTLE RIVER INLET.

TNTC = too numerous to count. lt = less than. mg/l = milligrams per liter. ml = milliliters. JTU = Jackson turbidity units. CaCO3 = calcium carbonate. N = nitrogen. P = phosphorus.

Parameter	General a/		Special: depth in ft. b/				Seasonal c/				Temporal c/				
	Range	Mean	0	5	15	25-28	Spring	Summer	Fall	Winter	1972	1973	1974	1975	1976
Alkalinity, mg/l as CaCO3	145-427	205	184	183	181	176	191	190	221	260	192	184	209	220	183
Ammonia, mg/l as N	-	-	0.03	0.03	0.05	0.10	-	-	-	-	-	-	-	-	-
Chloride, mg/l	21.0-128.0	39.2	-	-	-	-	35	46	30	31	31	31	29	34	35
Coliforms, no./100 ml	0-TNTC	1290	-	-	-	-	-	-	-	-	-	-	-	-	-
Dissolved oxygen, mg/l	lt 3.0-11.5	7.6	9.6	8.7	8.1	7.2	8.7	8.0	10.3	10.2	7.0	10.2	9.0	9.7	-
Hardness, mg/l as CaCO3	143-560	246	-	-	-	-	211	206	259	208	206	178	256	213	204
Iron, mg/l	0.02-3.2	1.6	-	-	-	-	-	-	-	-	-	-	-	-	-
Lead, mg/l	0.05-0.08	0.06	-	-	-	-	-	-	-	-	-	-	-	-	-
Manganese, mg/l	0.20-5.41	1.8	-	-	-	-	-	-	-	-	-	-	-	-	-
Kjeldahl nitrogen, mg/l as N	0.7-2.5	1.4	0.7	0.6	0.6	0.7	2.5	2.1	0.8	0.8	-	-	-	0.9	1.8
Nitrate + nitrite, mg/l as N	0.1-1.57	0.44	0.05	0.07	0.07	0.11	0.2	0.2	0.2	0.4	-	-	0.1	0.2	0.3
pH	7.3-8.8	8.1	8.49	8.46	8.39	8.35	8.3	8.3	8.0	8.2	8.6	8.0	8.1	8.2	8.4
Phosphorus, total, mg/l as P	lt 0.01-0.23	0.05	0.026	0.026	0.040	0.072	0.04	0.12	0.04	0.01	lt 0.01	0.05	0.05	0.03	-
Turbidity, JTU	5-500	84	-	-	-	-	28	22	11	22	28	26	13	15	-

a. 1969 to 1976. From: Canter, 1973, and OSDH (STORET data).
b. From EPA 1977a.
c. From OSDH (STORET).

As is common in lakes of this kind, the water is cleaner than the runoff which fills the lake. At least in part, this is because many pollutants are attached (sorbed) onto sediment and settle out with the sediment once the stream flow reaches the lake. Such a relationship can be broadly confirmed for Lake Thunderbird by performing a mass balance for phosphorus (see discussion on p. 6-24).

An assessment of lake quality was made by ACOG based on their review of existing data. The Little River basin and/or Lake Thunderbird were judged to have excessive iron, manganese, mercury, lead, taste, and odor, when compared to the recommended standards for a public water supply. Mercury levels in excess of standards for the protection of aquatic life were recorded for Little River, and manganese levels in Lake Thunderbird exceeded standards for irrigation. The problems for Little River/Lake Thunderbird were generally similar to or less severe than noted elsewhere in the ACOG region. Little River was the only major ACOG stream in which the recommended standards for phenol and dissolved solids were not exceeded.

Canadian River basin. Extensive data are available regarding water quality in the South Canadian River. Oklahoma's water-quality assessment (OSDH, 1980) indicates nutrient enrichment and high mineralization, suspended solids, and heavy metals for the segment from Bridgeport to Purcell. Toxic metal concentrations appear to be increasing over time; however, the biological condition of the river is improving. In the Norman area the river water is naturally hard and generally high in dissolved solids, iron and manganese. Wastewater discharges represent most or all of the stream flow during some parts of the year; Norman contributes about half of the wastewater discharged to the river as it passes through the ACOG region. Because of the high wastewater loading, the river is nutrient-rich. Nevertheless, dissolved oxygen levels are high. Very alkaline pH readings have been reported and are thought to result from severe algal blooms stimulated by the high nutrient levels. Nutrients from the South Canadian and other rivers are causing rapid eutrophication of Lake Eufaula.

The Oklahoma City/County Health Department collected water samples along the South Canadian in July and October of 1980; the data was used in calibration of the model that ACOG used in predicting the effect of various wasteload allocations (ACOG, 1981b). The sampling results are presented in tables A-2 and A-3 of appendix A. Note that for the October date, flow in the river below Norman is due almost entirely to Norman wastewater discharge. Ammonia, phosphorus, nitrate, oxygen demand and coliforms all increased in the river below the Norman wastewater treatment plant; however, dissolved oxygen levels also increased. This would indicate that aeration of the River was sufficient to meet the increased oxygen demand. The higher nutrient levels were reflected in higher chlorophyll a concentrations.

Oklahoma has developed a water-quality management plan for the South Canadian River (segment 520610; ODPC, 1979b). The segment is classified as Water Quality Limited for dissolved oxygen, pH, manganese, iron, temperature, copper, silver, turbidity, and chromium. In regard to nutrients, this segment is classified as "fair to poor", and is classified "poor" in regard to minerals. Analysis of nonpoint sources found the following:

- the South Canadian needs protection against sediment pollution which results from soil erosion due to poor agricultural practices;
- roadside erosion is low in Cleveland County;
- fertilizer and herbicide usage are low in Cleveland County; insecticide usage is moderate.

ACOG model. The most complete assessment of water quality in the area was performed by ACOG (1976a), and included an evaluation of flows from both urban and rural areas throughout the central Oklahoma region, inclusive of Norman. The ACOG research began with literature-based information obtained in the Tulsa area (AVCO, 1970) and nationwide (URS, 1974). The literature estimates of runoff quality were adjusted upward or downward based on the results of limited sampling conducted in central Oklahoma in 1976 and 1977; this sampling concentrated on urban streams outside the Little River basin. Because the ACOG estimates were based on the literature, and yet are modified to fit local data, they should provide a useful starting point for predicting the quality of runoff from different types of land use in the Norman area. LWA (1982a) presents an evaluation of the ACOG work.

The results of the ACOG work are summarized in table 6-4 and reveal that runoff from developed land is expected to carry much higher concentrations of most contaminants than runoff from open space. The greater pollution potential of urban runoff is especially notable for: total solids and suspended solids; biological and chemical oxygen demand; oil and grease; most forms of nitrogen; all forms of phosphorus; bacteria; and metals.

Comparison of table 6-4 to actual data from the Little River basin suggests that most values are accurate within a factor of two (which is a good level of agreement when dealing with streams in which flow conditions vary greatly over time). However, there is some indication that urban runoff is not as contaminated as suggested by table 6-4. For example, samples of urban runoff from the Moore area, collected by Jimmy Pigg (see Roach, 1974), indicate an orthophosphate level of 0.29 mg/l as P. ACOG's values for urban runoff are three to five times higher (1.09 to 1.63 mg/l as P). Consequently, table 6-4 may be viewed as a worst-case assessment when considering the impacts associated with changing land use from rural to urban.

ACOG provided specific estimates of water quality in runoff from various urbanizing basins in the ACOG area. Table 6-5 summarizes the results of the ACOG modeling for those basins which are within the Little River drainage and within Norman. Basin locations are shown in figure 6-6. Note that basin 28 also includes acreage outside of Norman. Under current (1975) land use conditions, basin 51, which has no development, is modeled to have low concentrations of most pollutants. However, in other basins the modeled runoff concentrations of iron and lead are greatly in excess of Oklahoma drinking water standards. Coliform numbers were also excessive; this is not as much a concern, since: a) the high numbers reflect a large proportion of soil bacteria

TABLE 6-4. QUALITY OF STORM RUNOFF IN THE CENTRAL OKLAHOMA AREA.

Typical concentrations of selected contaminants by type of land use. Based on limited sampling of runoff in the area, plus use of data gathered in Tulsa and elsewhere in the U.S. All values in mg/l (milligrams per liter), unless noted. ND = not detectable. ug/l = micrograms per liter. ml = milliliter.

	LAND USE			
PARAMETERS	Residential [a]	Commercial	Industrial	Open Space
Suspended solids	476	238	515	13.8
Total solids	1,324	646	1,421	38.4
pH (pH Units)	7.7	7.7	7.7	7.7
Biochemical oxygen demand	52.4	105	76.7	1.99
Chemical oxygen demand	96.0	155	631	22.8
Oil and grease	233	117	233	0.47
Total Kjeldahl nitrogen	3.35	6.29	3.35	0.42
Nitrate-nitrogen	1.13	1.51	0.75	0.75
Ammonia-nitrogen	0.52	0.97	0.52	0.07
Total phosphorus, as P	2.14	2.67	3.74	0.19
Orthophosphate, as P	1.09	1.36	1.63	0.08
Copper (ug/l)	148	105	206	ND
Cadmium (ug/l)	13.2	13.2	26.4	ND
Chromium (ug/l)	1.25	73.1	208	ND
Lead (ug/l)	735	904	1,130	ND
Zinc (ug/l)	695	521	744	ND
Iron[b] (ug/l)	155	97	213	ND
Mercury (ug/l)	3.84	2.09	1.48	ND
Nickel (ug/l)	11	10	17	ND
Manganese (ug/l)	159	79	234	ND
Strontium (ug/l)	8	4	11	ND
Fecal coliforms	55,859	32,845	65,691	56
Total coliforms (number/100 ml)	674,623	321,795	674,623	1,350

---

a. Residential areas studied were primarily low-moderate density, dominated by single-family homes.

b. ACOG reports that these numbers may reflect sampling errors.

Source: ACOG, 1977c.

TABLE 6-5. RESULTS OF ACOG URBAN RUNOFF MODELING, LITTLE RIVER BASIN, NORMAN, OKLAHOMA.

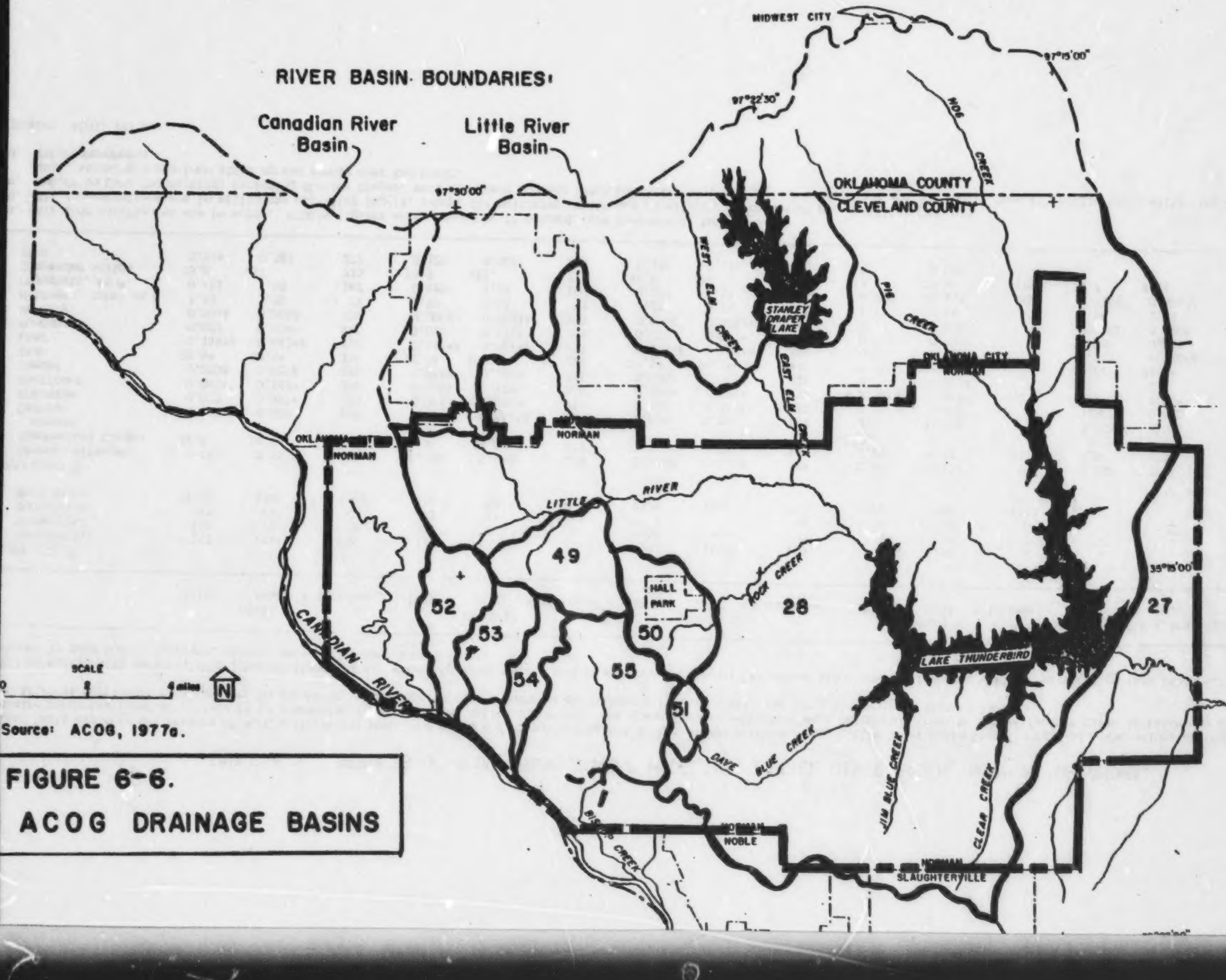
This table presents the results of ACOG's stormwater model for urban and urbanizing basins in the Norman portion of the Little River basin (see figure 6-6). The values are for "composite concentrations" of pollutants in stormwater runoff from the basin as a whole. The composite concentrations were calculated from the runoff factors given in table 6-4 and the relative proportion of each land use in the basin. ACOG modeled runoff both for conditions existing in 1975 and for projected land uses in 2000.

Values marked with an asterisk (*) exceed standards for water supplies; values marked with a pound symbol (#) exceed standards for fish and wildlife propagation (see table 4-2). Values in parentheses represent percent decrease, rather than increase.

	BASIN 28			BASIN 49			BASIN 50			BASIN 51			LITTLE RIVER BASIN[c]		
	1975	2000	% increase	1975	2000	% increase	1975	2000	% increase	1975	2000	% increase	1975	2000	% increase
LAND USE [a]															
Residential	213	1566	636	374	1333	256	267	1495	460	0	131	-	-	-	-
Commercial	118	147	24	142	256	80	409	409	0	0	0	0	-	-	-
Industrial	257	433	68	71	433	510	7	7	0	0	0	0	-	-	-
Open Space	3265	1709	(48)	2416	981	(59)	2325	1096	(53)	921	790	(14)	-	-	-
POLLUTANT [b]															
Ammonia-nitrogen	0.153	0.338#	121	0.180	0.412#	129	0.234#	0.418#	79	0.070	0.134	91	0.100	0.148	48
Biochemical oxygen demand	12.9	34.8	170	14.9	44.0	195	20.7	41.3	100	1.99	9.17	361	5.54	11.2	102
Cadmium	0.003	0.009	200	0.003	0.011*#	267	0.003	0.008	167	0	0.002	-	0.0008	0.002	150
Chromium	0.023	0.077*	235	0.024	0.092*	283	0.022	0.073*	232	0	0.018	-	0.007	0.020	186
Coliforms	0.093*	0.363*	290	0.116*	0.425*	266	0.106*	0.381*	259	0.0014	0.097*	6829	0.335*	1.01*	201
Copper	0.025#	0.087#	248	0.028#	0.104#	271	0.028#	0.088#	214	0	0.021#	-	-	-	-
Iron	25.8*	90.5*	251	28.9*	108.*	274	27.5*	90.7*	230	0	22.0*	-	8.22*	24.4*	197
Lead	0.144*#	0.461*#	220	0.161*#	0.567*#	252	0.191*#	0.492*#	158	0	0.105*	-	0.045	0.126*#	180
Manganese	0.027	0.094*	248	0.029	0.111*	283	0.025	0.090*	260	0	0.023	-	0.008	0.025	213
Mercury	0.0004	0.0018	350	0.0006	0.0021*#	250	0.0006	0.0022*#	267	0	0.001	-	0.0001	0.0005	400
Nitrogen, total as N	1.75	3.10	77	1.97	3.64	85	2.38	3.74	57	1.17	1.64	40	1.38	1.74	26
Phosphate, as P	0.611	1.48	142	0.635	1.78	180	0.709	1.51	113	0.190	0.467	146	0.316[d]	0.534[d]	69
Suspended solids	79.8	267.	235	93.9	311.	231	86.6	276.	219	13.8	79.5	476	36.3	83.2	129
Zinc	0.104	0.387	272	0.129	0.462	258	0.135	0.419	210	0	0.099	-	-	-	-

a. All land use figures are in acres. ACOG's figures were reduced by 11 percent (see footnote d, table 6-17).
b. All concentrations are in milligrams per liter (mg/l), except for coliforms, which are in millions of organisms per deciliter (100 ml).
c. Runoff to Lake Thunderbird, excluding Stanley Draper, West Elm Creek and Hog Creek Lakes drainage basins. Concentrations are for runoff from the entire basin within the ACOG area, assuming a one-inch storm spread evenly over the basin.
d. Total phosphorus.

Source: ACOG, 1977c.


RIVER BASIN BOUNDARIES:
Canadian River Basin
Little River Basin
MIDWEST CITY
97°15'00"
97°22'30"
97°30'00"
OKLAHOMA COUNTY
CLEVELAND COUNTY
HOG CREEK
PIG CREEK
WEST ELM CREEK
EAST ELM CREEK
STANLEY DRAPER LAKE
OKLAHOMA CITY
NORMAN
OKLAHOMA CITY
NORMAN
NORMAN
LITTLE RIVER
ROCK CREEK
HALL PARK
LAKE THUNDERBIRD
DAVE BLUE CREEK
JIM BLUE CREEK
CLEAR CREEK
NORMAN
NOBLE
NORMAN
SLAUGHTERVILLE
BISHOP CREEK
CANADIAN RIVER
35°15'00"
27
28
49
50
51
52
53
54
55
SCALE
0
2
4 miles
N

Source: ACOG, 1977a.

FIGURE 6-6.
ACOG DRAINAGE BASINS

(not of fecal origin), and b) coliforms are subject to rapid dieoff. Modeled runoff concentrations for ammonia, cadmium, copper, iron, lead, mercury, and zinc were determined to be in excess of desirable limits for the protection of aquatic life. BOD levels indicate the potential for excessive oxygen depletion within the streams which drain the area.

The last column of table 6-5 gives pollutant concentrations in stormwater runoff to Lake Thunderbird from the entire basin. ACOG excluded the drainage area to Lake Stanley Draper from this analysis, with the assumption that runoff would carry pollutants into that lake rather than Thunderbird. They also excluded drainage into hypothetical lakes on West Elm Creek and Hog Creek, so that the values in table 6-5 are perhaps somewhat low. The modeled runoff concentrations to Lake Thunderbird are much lower than those from urbanized subbasins (that is, runoff from urbanized basins is diluted by runoff from non-urbanized basins). Under existing conditions, water supply standards are exceeded only for iron and coliforms.

ACOG's analyses were also performed for urban basins within the South Canadian River basin. Table 6-6 summarizes the estimated pollutant loadings which ACOG developed for runoff from basins within the Norman city limits (see figure 6-6). The modeled runoff concentrations for current (1975) land use conditions are in excess of drinking water standards for iron, manganese, lead, coliforms, and chromium. Ammonia, cadmium, copper, iron, lead, mercury, and zinc exceed desirable limits for the protection of aquatic life. Potential for oxygen depletion is indicated by high BOD levels. These problems are least severe in basin 52, which is not as extensively urbanized as the other basins.

The last column of table 6-6 presents runoff concentrations to the Canadian River from the basin as a whole. The modeled concentrations are lower than those from the urbanized basins in Norman. Under current conditions, iron, lead and coliforms are modeled to exceed standards for water supplies.

Pollutant loadings to Lake Thunderbird. As a final step in evaluating existing conditions, ACOG utilized the results of its stormwater model in conjunction with other data to predict the total loading of pollutants into Lake Thunderbird and into the South Canadian. Table 6-7 summarizes the loadings estimated by ACOG for Lake Thunderbird. In general the findings of table 6-7 are at least broadly consistent with other information about the Little River basin. Using ACOG's loadings for phosphorus and sediment, and accounting for phosphorus removed by pumping and outflow from the lake and for phosphorus in the water of the lake (at 0.5 mg/l), it can be calculated that the lake sediment would contain 0.32 milligrams of phosphorus per gram of sediment. Actual data by Lee (1974) give a higher value of 0.41 mg/g; however, Lee collected his data in 1973 and 1974, after a period of unusually high runoff. In any case, the observed and estimated sediment phosphorus levels are in reasonable agreement, given the many uncertainties in the phosphorus budget.

TABLE 6-6. RESULTS OF ACOG URBAN RUNOFF MODELING, SOUTH CANADIAN RIVER BASIN, NORMAN, OKLAHOMA.

This table presents the results of ACOG's stormwater model for urban and urbanizing basins in the Norman portion of the Canadian River basin (see figure 6-6.) The values are for "composite concentrations" of pollutants in stormwater runoff from the basin as a whole. The composite concentrations were calculated from the runoff factors given in table 6-4 and the relative proportion of each land use in the basin. ACOG modeled runoff both for existing conditions in 1975 and for projected land uses in 2000.

Values marked with an asterisk (*) exceed standards for water supplies; values marked with a pound symbol (#) exceed standards for fish and wildlife propagation (see table 4-2). Values in parentheses represent percent decrease, rather than increase.

	BASIN 52			BASIN 53			BASIN 54			BASIN 55			CANADIAN RIVER BASIN c/		
	1975	2000	% increase	1975	2000	% increase	1975	2000	% increase	1975	2000	% increase	1975	2000	% increase
LAND USE a/															
Residential	160.	1296	709	828	877	6	774	993	28	1157	1542	33	-	-	-
Commerical	64	188	193	338	344	2	436	438	0.4	1593	2006	26	-	-	-
Industrial	44	233	424	27	127	377	4	13	225	71	505	611	-	-	-
Open Space	2314	866	(63)	1006	850	(15)	512	282	(45)	2955	1723	(42)	-	-	-
POLLUTANT b/															
Ammonia-nitrogen	0.128	0.402#	214	0.384#	0.417#	9	0.501#	0.561#	12	0.414#	0.543#	31	0.116	0.140	21
Biochemical oxygen demand	8.97	41.6	364	37.8	42.6	13	50.9	57.8	14	41.5	57.8	39	7.42	10.2	37
Cadmium	0.002	0.010	400	0.007	0.009	29	0.009	0.011*#	22	0.007	0.010	43	0.001	0.002	100
Chromium	0.013	0.087*	569	0.061*	0.073*	20	0.075*	0.092*	23	0.048	0.077*	60	0.008	0.014	75
Coliforms	0.063*	0.424*	573	0.312*	0.359*	15	0.386*	0.475*	23	0.233*	0.351*	51	0.418*	0.713*	71
Copper	0.015#	0.100#	567	0.074#	0.087#	18	0.093#	0.113#	22	0.061#	0.094#	54	-	-	-
Iron	15.7*	104.*	562	75.8*	89.3*	18	94.5*	115.*	22	60.4*	93.7*	55	10.4*	17.5*	68
Lead	0.088*	0.538*#	511	0.430*#	0.501*#	17	0.562*#	0.662*#	18	0.411*#	0.610*#	48	0.063*	0.099*	57
Manganese	0.016	0.107*	569	0.075*	0.089*	19	0.092*	0.113*	23	0.056*	0.090*	61	0.010	0.017	70
Mercury	0.0003	0.0022*#	633	0.0018	0.0019	6	0.0023*#	0.0027*#	17	0.0014	0.0019	36	0.0002	0.0003	50
Nitrogen, total as N	1.59	3.59	126	3.48	3.71	7	4.35	4.79	10	3.70	4.62	25	1.51	1.68	11
Phosphate, as P	0.434	1.67	285	1.35	1.56	16	1.70	1.97	16	1.31	1.88	44	0.363d/	0.462d/	27
Suspended solids	56.7	308.	443	229.	263.	15	279.	341.	22	174.	259.	49	42.0	62.4	49
Zinc	0.069	0.099	43	0.352	0.403	14	0.446	0.539	21	0.292	0.432	48	-	-	-

a. All land use figures are in acres. ACOG's figures were reduced by 11 percent (see footnote d, table 6-17).
b. All concentrations are in milligrams per liter (mg/l), except for coliforms, which are in millions of organisms per deciliter (100 ml).
c. Canadian River at the Cleveland-Pottawatomie county line, excluding Union Lake drainage basin. Concentrations are for runoff from the entire basin within the AGOG area, assuming a one-inch storm spread evenly over the basin.
d. Total phosphorus.

Source: ACOG, 1977c.

TABLE 6-7. ESTIMATED ANNUAL SEDIMENT AND NUTRIENT LOADINGS TO LAKE THUNDERBIRD UNDER EXISTING (1975) LAND USE CONDITIONS.

Source of Loading	Sediment Tons/Year	Phosphorus Pounds/Year	Nitrogen Pounds/Year
Point source discharge	0	0	0
Runoff from urban and urbanizing basins	1,855	24,007	73,890
Runoff from rural areas a/	87,963	52,203	480,943
Erosion from secondary roadsides	23,073	0	0
Rainfall onto Lake Thunderbird and other water bodies	0	651	22,467
Septic tanks: concentrated areas	0	0	0
TOTAL b/	112,891	76,861	577,300

a. Includes urban and low-density subdivisions outside of the basins indicated figure 6-6.

b. Excludes drainage area above Lake Stanley Draper.

Source: ACOG, 1977e.

Lee, Rast, and Jones (1978) have developed a model which relates phosphorus inputs to chlorophyll levels. Using ACOG's phosphorus loading of 76,861 pounds per year (see table 6-7), the model predicts a chlorophyll a level of 36 ug/l, which is substantially higher than observed. However, the discrepency between observation and prediction is consistent with findings in other turbid reservoirs. For example, in Lake of the Ozarks, Missouri, sediment turbidity reduced light penetration into the reservoir, such that only about 30 percent of the chlorophyll a is produced per unit of phosphorus as would be produced in non-turbid conditions (Novak et al., 1979). Based on comparisons of turbidity, the effects in Lake Thunderbird would be slightly less. These results are consistent with the observation that chlorophyll a production in Lake Thunderbird is less than half the predicted amount. Because the chlorophyll production is about what would be expected on the basis of the estimated phosphorus loadings and turbidity, it is reasonable to conclude that the loading estimate is approximately correct.

Although phosphorus loading correlates reasonably well with chlorophyll levels in the lake, the estimated sediment loading is much less than has been reported in qualitative studies such as Crowley and Johnson (1978). The ACOG estimate of sediment yield was taken from studies performed by the Soil Conservation Service (SCS), and includes upland erosion (calculated using the Universal Soil Loss Equation), gully erosion, and erosion along roadsides. An evaluation of the estimate contained in LWA (1982a) supports the conclusion reached, which is that the total gross erosion in the basin is about 4,300 pounds/acre/year. SCS estimated that about 30 to 40 percent of the gross erosion would reach Lake Thunderbird. Using a value of 33 percent, total sediment delivery to the reservoir would be about 1,400 pounds/acre/year. If this evaluation is accurate, qualitative statements that the sediment load to Lake Thunderbird is "extremely high" are not correct.

Note that much of the phosphorus loading to the lake is due to phosphorus that is naturally associated with the sediment load. This is shown in table 6-7; at the concentrations indicated, and assuming a net sediment yield of 1,400 pounds per acre per year, soil erosion can account for essentially all the phosphorus delivered to Lake Thunderbird. Moreover, as noted in LWA (1982a), precipitation may also be an important phosphorus source in the watershed. This supports other observations that sources such as fertilizer use, animal wastes and human sewage are relatively unimportant in the basin, and it indicates that runoff management and erosion control would be the keys to any effort intended to reduce phosphorus loadings into Lake Thunderbird.

Pollutant loadings to the Canadian River. Table 6-8 presents the results of ACOG's modeling of total pollutant loadings to the Canadian River within the ACOG area. A large portion of the nutrient loading is attributed to point sources, that is, wastewater discharges.

Ground water. Data on ground-water quality are available from wells throughout the area. Portions of the Garber-Wellington aquifer contain saline water, but in the fresh water zones quality is generally good and the water requires no treatment (except disinfection) for drinking. High nitrate values

TABLE 6-8. ESTIMATED ANNUAL SEDIMENT AND NUTRIENT LOADINGS FROM THE ACOG REGION INTO THE CANADIAN RIVER UNDER EXISTING (1975) LAND USE CONDITIONS.

The figures given below are modeled for the South Canadian River between river miles 0 and 78.7.

Source of Loading	Sediment Tons/Year	Phosphorus Pounds/Year	Nitrogen Pounds/Year
Point source discharge a/	268	247,553	995,822
Runoff from urban and urbanizing basins	3,294	43,904	122,104
Runoff from rural areas b/	148,635	171,853	782,716
Erosion from secondary roadsides	8,953	0	0
Rainfall on surface water	0	1,223	42,174
Septic tanks: concentrated areas	0	0	4,106
TOTAL	161,150	464,533	1,946,922

a. Includes sources in Union City, Oklahoma City, Moore, Norman, Noble, and Lexington. The amount of pollutant contribution could not be determined for some of the point sources which were identified.

b. Includes urban and low-density subdivisions outside of the basins indicated on figure 6-6.

Source: ACOG, 1977e.

observed in scattered wells in the Little River basin and elsewhere suggest that there are local situations in which septic tank effluent and/or agricultural practices may have contaminated small areas in the upper zone of the aquifer.

6.2.4 Existing Conditions: Water Supply

Norman's water supply comes from two sources: deep wells and Lake Thunderbird. The lake and the wells combined can provide 12.2 million gallons per day (MGD) of water to the distribution system. The supply of water to the city from Lake Thunderbird is about 9,460 acre-feet per year (8.4 MGD), of which 72 percent currently can be diverted with the facilities available. Demand for water has been growing at a faster rate than the population; total demand averaged 5.7 MGD in 1977. The peak demand in summer is approximately twice the average demand, and can exceed the capacity of the system. An additional 4.9 MGD capacity for water supply is provided separately by Central State Hospital and the University of Oklahoma. Wastewater from these institutions is discharged to the Norman sewer system.

6.2.5 Impacts of the No Action Alternative

Impacts of growth on water quality are discussed below (6.2.6). To the extent that development is discouraged by lack of sewerage service, these impacts would not occur under the No Action alternative. However, a more likely scenario is that growth would still occur, but in a more spread-out manner. The runoff from the extra acreage developed in such a case (e.g., far more roads) might result in even more increase in pollutant loadings than would occur under the proposed action. On-site systems used by unsewered development would have the potential to contaminate ground water supplies.

As described in 5.1, organic overloading of the present treatment facilities results in an effluent too high in biological oxygen demand (BOD). Under the No Action alternative, increased wastewater flows would further overload the plant, causing effluent BOD to increase. This would have adverse impacts on the water quality of the Canadian River.

Currently, a portion of Norman's sludge is disposed of within the 100-year flood plain. Under flood conditions, pathogens and other pollutants from the sludge could be washed into the Canadian River or into shallow domestic wells. Under the No Action alternative, this would remain a potential hazard.

6.2.6 Impacts of Collection Alternatives

Construction impacts. Siltation and sedimentation are not expected to be significant based on engineering experience in the area (Painter, 1980). However, specifications to the building contractor would require that precautions such as described earlier for erosion and sediment control be taken, and that any necessary cleanup be accomplished immediately.

Sewer construction may require dewatering in order to prevent water from standing in excavated trenches. Dewatering generally involves installation of wells near the trench and pumping to lower the water table. The pumped water is discharged to an irrigation drain or storm sewer. Two types of impacts result. First, shallow domestic wells near the trench may experience a drop in water levels; in extreme cases the wells may dry up for a short period, and it is possible pumps could incur permanent damage. Second, the pumped water is normally from the uppermost portion of the aquifer, which may contain high amounts of iron, manganese or other dissolved solids and which may have a slight odor. If the trench is near a cesspool or saturated drainfield, excess bacteria may be found in the water. Finally, the pumping process can result in the water being turbid, with an excessive silt load.

To avoid the adverse impacts of water table lowering, it would be necessary to evaluate the extent of water table decline near a trench and to identify all wells along a construction route which may be affected. Well owners would then be advised of the problem, and instructed to utilize pumps on a manual basis only. If a serious water level decline is observed, the contractor would be required to provide an alternate supply until the water table recovers.

The discharge from trench dewatering normally requires permission from the city if a storm sewer is to be used. Problems of sediment quality are managed by utilizing sand-point wells, which are relatively protected against the influx of silt. Where appropriate, the outfall from dewatering can be designed to control erosion by minimizing discharge velocity and turbulence. Other water-quality aspects of the discharge water are not normally regulated, since the ground water would naturally flow to irrigation drains and the river.

Impact of growth on water quality. Construction of the proposed collection system would facilitate new development in both the Little River and Canadian River basins. As is clear from table 6-4, any conversion of open space to residential, commercial, or industrial use would result in significant increases in pollutant concentrations in runoff from the area. This would impact the water quality of Lake Thunderbird and the South Canadian River. This section broadly quantifies and assesses the extent of such impacts. While concentrations of many types of pollutants would be increased, discussion in this section focuses primarily on phosphorus, because of its role in eutrophication of Lake Thunderbird. Phosphorus generally is the controlling factor in the amount of algae which can grow in the lake; this in turn has implications for odors, tastes, and the viablilty of other aquatic life. Discussion of this one parameter will illustrate the magnitude of water-quality changes.

Growth projections for Norman and the Little River basin are presented in section 6.6.2. The proposed action would permit 1030 acres of residential land in the Little River basin to be developed at densities of 8-10 people per acre or roughly 4 units per acre. It would also facilitate the development of up to 90 acres of industrial land. This would increase the amount of surface runoff flowing into streams feeding Lake Thunderbird. Similarly, in the Canadian River basin 375 acres would be developed at 8-12 people/acre, increasing urban runoff to the South Canadian River. Thus, the proposed action would facilitate the urbanization of roughly 1,500 acres of land, with consequent increases of contaminants to the Little River, Lake Thunderbird, the Canadian River, and their tributaries.

The greatest change in the quality of surface water runoff would occur in those basins experiencing the greatest amount of urbanization during the study period. The type of change to be expected can be estimated through use of ACOG's stormwater model. Impacts identified by the ACOG model indicate the magnitude and direction of change but should not be construed to represent precise values. ACOG's analysis is based on drainage basin designations which differ from those used in the facilities plan (see figure 6-6). Further, projected growth varies for some parts of Norman between the two studies. Still, the differences between ACOG and the facilities plan are small enough that the results of the ACOG model should identify the nature of the changes which can be expected.

Tables 6-5 and 6-6 give ACOG's results for modeling of runoff from subbasins in the Little River and Canadian River basins for the year 2000. The results of the model clearly show the impacts of urbanization. The basins covering the downtown area (basins 53, 54, 55) already have high levels of pollutant concentrations and these levels are projected to increase through the year 2000. The greatest magnitude of change would occur in the urbanizing basins on the fringe of the developed area (basins 49, 50, and 52). In these areas modeled water quality already exceeds some drinking water and aquatic standards; however, by the year 2000, water quality in these basins would approach the higher levels common in the city. This situation is also true in basin 28 which includes most of the Little River drainage in Norman. ACOG and the facilities plan growth projections for this basin vary; specifically, it is likely that growth in this area will be greater than projected by ACOG. Thus, the change in pollutant levels is likely to be somewhat greater than shown in the table, but still comparable to values shown for the urban basins. The most significant impact would be in basin 51, which is located southeast of the urban area. This area is virtually undeveloped; therefore, the modeled runoff in this basin is of fairly good quality. For existing conditions, there are no detectable concentrations of metals in the water and no pollutant concentrations in excess of drinking water and aquatic standards. While the modeled concentrations for the year 2000 are still low compared to other basins, water quality is projected to change to the extent of exceeding some drinking water and aquatic-life protection standards.

Thus, the values in tables 6-5 and 6-6 indicate that the runoff from the urbanized areas would contain pollutants in amounts which are greater than desirable. In particular, aquatic standards for ammonia and some metals (e.g. cadmium, lead) would be exceeded, and biological oxygen demand could cause oxygen depletion. In the immediate vicinity of the growth areas, the runoff could adversely affect aquatic life (see section 6.4.4).

For the Little River watershed, the magnitude of change in water quality can be illustrated by looking at phosphorous loadings. ACOG's data (table 6-4) can be converted further to give estimates of phosphorous loadings from various types of land use; the methodology for doing this is explained in the Little River report (LWA, 1982a). Depending on interpretation of ACOG's model, residential areas are calculated to contribute 3.8 pounds per acre per year. This figure is also representative of values found in the technical literature. Rural areas are calculated to contribute only 0.17 pounds per acre per year. Thus, the conversion to urban acreage increases phosphorus loadings by 3.6 pounds per acre per year. Similarly, industrial areas are calculated to contribute 6.8 pounds per acre per year, or in comparison to open space, an additional 6.6 pounds per acre. Application of these loading factors to the projected land use changes within the Little River basin (1,030 rural acres to residential and 90 rural acres to industrial) results in estimated phosphorous loading increases of at least 4,340 pounds per year as an indirect result of the proposed collection system. This represents an increase of 5.6 percent in the total phosphorous loading to Lake Thunderbird (see table 6-7). Within the Canadian River basin, phosphorous loadings are calculated to increase by 1,350 pounds per year, a 0.3 percent increase in phosphorous loadings to the Canadian River (see table 6-8).

These figures represent only a portion of the total change which would occur to Lake Thunderbird and to the Canadian River. To assess the likely impact of the proposed action, they must be considered in the context of the cumulative impact of all growth in the basin. The Little River basin includes portions of several other communities: Oklahoma City, Moore, Midwest City, Slaughterville, Hall Park and Noble, as well as some unincorportated areas of Cleveland County. In addition, development in Norman's rural area (not served by the proposed sewers) would also contribute to increases in pollutant loadings to the lake.

ACOG's land development projections indicate that a total of about 12,000 acres in the Little River basin would be developed between 1977 and 2000. This would increase phosphorus loadings by nearly 42,000 pounds per year, a 55 percent increase in total loadings.

In the rural area of Norman the population is projected to increase by 6,499 people at a density of 0.6 to 1.4 people per acre, thus involving several thousand acres of land. However, this acreage would not be developed at an urban level, and the growth would not have the effects shown in table 6-4. A better comparison is to use the 'equivalent urban acreage', or the land which would be urbanized if the 6,499 persons were to locate in areas having an urban density of 8 people/acre. Using this comparison, the growth in rural areas has a water-quality impact equivalent to the effects of a higher-density urbanization of 812 acres during the planning period. This would increase phosphorus loadings by 2,950 pounds per year, which is 4 percent increase over current loadings to the lake. As discussed previously, development in sewered areas in Norman would increase phosphorus loadings by 4,340 pounds per year. The combined effect of urban and rural growth is thus 7,290 pounds per year of increased phosphorus loadings to Lake Thunderbird, or about a 10 percent increment. This impact reflects only growth through the year 2000. Continued development past that time would have an additional water-quality effect (see 5.2.1); the effect has not been calculated here, since the proposed facilities would not be sized to accommodate growth past the year 2000.

To judge the importance of growth in Norman, it is useful to consider how development in Moore would impact Lake Thunderbird. Using ACOG's land use figures, nearly 5000 acres in the Little River watershed in Moore will urbanize by year 2000. This would increase phosphorus loadings by 19,245 pounds per year, or about 25 percent above current loadings to the lake. This is six times the impact of growth in urban Norman, and 2.5 times the impact of growth in all of Norman. Thus, growth in Norman is only one factor causing water-quality changes in Lake Thunderbird; effective control of pollutant loadings in the Little River basin would require basin-wide coordination and management.

Impacts of growth on Lake Thunderbird. Table 6-5 indicates that the concentrations of pollutants entering Lake Thunderbird are expected to increase by 26 to 400 percent by the year 2000. Standards for coliforms, iron, and lead would be exceeded. The coliforms are subject to rapid dieoff, but could interfere with recreational use following major runoff events. Iron standards are set for reasons of aesthetics; excessive levels might cause taste problems, but would not be adverse to health. Treatment of Lake Thunderbird water to remove the iron would control this impact. The excessive lead levels would be of concern, since this metal is highly toxic to both humans and aquatic life. It is likely, though, that most of the lead in runoff would be associated with sediment, so that actual levels in the water would not be excessive (see Hall et al., 1977).

Section 6.2.1 presents a calculation for chlorophyll a levels in Lake Thunderbird assuming ACOG's modeled phosphorus loading. Using the model of Lee, Rast and Jones, the value of 36 ug/l was obtained. This same model was used to calculate chlorophyll a levels in the year 2000, given the increased phosphorus loadings just presented. The calculation also took into account the fact that the lake volume will be decreased due to siltation. The results of the model show that phosphorus increases due to growth in sewered areas would increase chlorophyll a levels to 39 ug/l, an 8 percent increase. Phosphorus increases from the entire basin would increase chlorophyll to 52 ug/l, a 45 percent increase.

As discussed in section 6.2.1, average chlorophyll a levels in Lake Thunderbird are actually less than half that predicted by the model of Lee, Rast and Jones. This is probably due to turbidity in the lake, which prevents light from entering the lake in sufficient amounts to support the indicated amount of algae. Thus, future phosphorus levels would probably also be much less than indicated by the model. In fact, since light is such a limiting factor on algal growth in the lake, chlorophyll a levels may increase very little, even with the increases in phosphorus levels. However, given the current state-of-the-art, it is very difficult to assess the extent of changes in Lake Thunderbird resulting from projected growth. See LWA (1982a) for further discussion.

The studies of Lake of the Ozarks cited in section 6.2.1 indicate that the effect of sediment traps above a turbid reservoir have a net benefit in water quality. That is, reduction in sediment substantially reduces the availability of phosphorus, and even though there is more light penetrating the reservoir, the net effect is reduced chlorophyll a production. Data from Lake Thunderbird show similar patterns, with less productivity occurring in the clearer part of the lake. From this observation it is inferred that the numerous small ponds within the basin benefit water quality in Lake Thunderbird. Another factor serving to minimize impacts is the fact that much phosphorus is associated with natural soils; as discussed in 6.1.1, phosphorus rich soils are especially abundant in bottomlands. Norman's practice of maintaining open space along bottomlands helps to limit development on soils having a high phosphorous content.

Based on the Lake of the Ozarks studies, development of sediment and erosion control plans to mitigate effects of urbanization is an effective mitigation measure. Examples of items to be included in such plans would be: requirements to build ponds that would act as sediment traps; regulation of construction practices to control sediment in runoff; and restriction of development in bottomlands.

Impacts of growth on the Canadian River. Increases of 11 to 100 percent are modeled for pollutants in runoff to the Canadian (see table 6-6). No water-quality standards would be exceeded in the year 2000 which are not already exceeded, according to ACOG's model. As stated above, the increase in phosphorus loadings to the Canadian due to urbanization in Norman associated with the proposed action would be only 0.3 percent. Such a small increase would not have any noticeable impact on the river or Lake Eufaula.

Impacts on flood hazard areas. Construction in flood hazard zones may occur in the case of interceptors proposed for Normandy (Merkle) Creek, Imhoff Creek, Bishop Creek and Rock Creek. Figures 6-2 through 6-5 locate the generalized routes of these lines with respect to flood hazard areas mapped by the Federal Insurance Administration. Specific line locations will not be available until surveying is undertaken during detailed design of the project.

A notice concerning the possibility of construction in flood plains has been prepared as part of this EIS in accordance with EPA procedures for implementation of NEPA (40 CFR, Part 6C, Subsection 6.302(b)). The notice is being circulated with this EIS as the last entry in appendix C.

The principal impacts of construction in a flood plain are the potential for encroachment and the potential for erosion. Encroachment can be caused by such measures as installation of sewer access holes or artificial fill, and can result in raising of the flood level, either through addition of mass or by obstruction of flood flows.

Proposed interceptors are from 10 to 33 inches in diameter, requiring trenches from as little as several feet deep and wide to over 10 feet deep and wide. Such excavations create the potential for erosion and for disturbance of the flood channel and for obstruction of flood flows. Specific impacts and mitigation measures are included in table 5-3 and in the discussion in section 6.1.3.

Two alternatives are available for the use of sewer access holes in flood plains. To avoid obstruction of flood flows and creation of aesthetic nuisance, interceptors can be fitted with sealed, locking sewer access holes that are flush with the ground surface. Use of such utility holes is particularly appropriate where floods are sudden and debris-laden in nature, where there is a lack of vegetation to offset any aesthetic intrusion, and where the potential for inflow is not frequent. Alternatively, sewer access holes can be extended from interceptors with long necks, with the access placed at least one foot above the 100-year flood elevation. Traditionally, the latter have been used in Norman.

No proposed lift station will be located within a 100-year flood plain.

6.2.7 Impacts of Treatment Alternatives

Surface water. As explained in section 4.3, ACOG has developed several levels of wasteload allocations, depending on the degree of water-quality protection desired (see table 4-3). ACOG modeled water quality in the South Canadian under low-flow conditions for each level of wastewater treatment; the results are summarized in table 6-9. Treatment level 3a (facilities plan level C) would be required in order to insure dissolved oxygen levels which would protect the South Canadian as a warm-water fishery. However, the Oklahoma Water Resources Board is considering a change in the beneficial use designation for the South Canadian to "secondary warm-water fishery"; that is, it would be understood that during low-flow conditions, fish propagation in the River would be inhibited. See section 6.4.5 for further discussion of the relationship between treatment levels and fish propagation in the Canadian River.

Treatment alternatives 1, 2, 3 and 4 are all designed to meet level A treatment requirements, with the result that South Canadian water quality would be suitable for cooling water, primary and secondary contact recreation, and agriculture. Alternatives 2 and 3 are given the best reliability ratings in table 5-5; thus, implementation of these alternatives would give the best assurance that water quality standards for the South Canadian would not be violated. Likewise, for Level D treatment, alternative 6 is is given the best reliability rating and so would be most likely to protect water quality.

The proposed action does not involve discharge of dredged or fill material below the ordinary high water mark of the South Canadian River. Therefore a

TABLE 6-9. MODELED QUALITY OF THE SOUTH CANADIAN RIVER FOR ALTERNATIVE LEVELS OF WASTEWATER TREATMENT.

As part of this wasteload allocation study, ACOG modeled South Candadian water quality during low-flow conditions, assuming various levels of wastewater treatment. The figures below are for the river one-half mile below Norman's wastewater discharge. The entire flow at this point (14.7 cfs) would be due to Norman's discharge. See table 4-3 for an explanation of the treatment levels.

All figures are in milligrams per liter (mg/l), except for chlorophyll a, which is in micrograms per liter (ug/l).

	TREATMENT LEVEL			
PARAMETER	A	B	C	D
Dissolved oxygen				
minimum	2.8	3.2	4.9	5.3
maximum	3.7	4.1	6.0	6.4
average	3.3	3.7	5.5	5.9
Ultimate biochemical oxygen demand	28.9	14.4	14.4	7.2
Ammonia-nitrogen	10.0	9.9	1.6	1.6
Nitrate plus nitrite nitrogen	9.9	9.9	18.2	2.3
Orthophosphate, as P	10.0	8.0	8.0	1.0
Chlorophyll a	11.	11.	11.	11.

Source: ACOG, 1981b.

Department of the Army Section 404 permit will not be required. Also, as the South Canadian at Norman is not a navigable water of the United States, work associated with this proposal will not require authorization under Section 10 of the River and Harbor Act of 1899 (see Corps of Engineers letter, appendix C).

Alternative 7 (land application) eliminates discharge to the South Canadian altogether. On the one hand, this insures that no adverse impacts on the river would result from malfunction of the treatment facilities. On the other hand, during some periods Norman's wastewater discharge is the only source of flow in the river below Norman; without this input, the river would provide no water-dependent benefits whatsoever.

Ground water. Alternative 7, land application, has the potential to adversely impact ground water due to migration of contaminants in the wastewater down into the water table. Nitrate is the contaminant of greatest concern. Application rates would be designed so that all nitrogen would be taken up by crops. In addition, ground water at the application site would be monitored to insure that contaminant levels are not increasing above acceptable limits.

Flood hazard areas. All proposed treatment facilities are located outside of the 100-year flood plain (refer to figure 6-2).

6.2.8 Impacts of Sludge Management Alternatives

A basic concern with land application of sludge (alternatives 1 and 2) is that contaminants might leach out of the sludge and into the underlying ground water. The contaminant of greatest concern is nitrate, which is a health hazard when present at high levels in drinking water. Sludge contains large amounts of nitrogen which may oxidize to nitrate when applied to the ground. Nitrate is very soluble in water, and so is easily transported down to the water table. The potential for leaching of contaminants is greater with alternative 2 than with alternative 1, since alternative 2 proposes to apply all sludge in liquid form.

The facilities plan proposes that crops such as alfalfa be grown at the sludge application site; the vegetation would utilize nitrogen, thus reducing the amount of nitrate available to seep into the ground water. The ground water at the site would be monitored for nitrates, metals, and other pollutants so that any pollution that might occur would be detected, and mitigation measures could be implemented.

Runoff from the land application site would carry pathogens, nutrients and other pollutants from sludge into the South Canadian River. Such problems would be minimal due to the gentle slope of the proposed application site and the fact that the sludge will be incorporated into the soil. An earthen berm could also be constructed around the disposal area.

The incineration alternatives (3 and 4) would produce an ash relatively rich in metals which could leach into the ground water at the landfill site; this problem would be minimized because the ash is also alkaline, which reduces the solubility of metals. Runoff from the ash and chemical sludge disposal site could carry pollutants into Bishop Creek. The landfill would need to be designed and operated to minimize ground water contamination and runoff; monitoring wells would be installed at the site.

Flood hazard areas. All proposed sludge treatment and disposal facilities are located outside of the 100-year flood plain (see figures 5-4 and 6-2).

6.2.9 Impacts of Other Alternatives

For the most part, actions taken with respect to energy conservation, odor control, administration, and funding have no direct impacts on water resources. Those impacts which do occur would be similar for all alternatives described in section 5.5.

The continued use of on-site systems in rural areas (section 5.5.1) has the potential to cause contamination of ground water, by the buildup of nitrates or other contaminants. Adherence to state regulations mitigates potential contamination. Upgrading of on-site system requirements would reduce the likelihood of ground-water degradation.

The use of chlorine for disinfection (section 5.5.2) has the potential to cause water-quality problems, such as formation of toxic chlorine residuals and trihalomethanes. If chlorine residuals are excessive in summer months, the fish population of the Canadian River could be adversely impacted, since at that time most if not all of the aquatic environment is supplied by the Norman wastewater discharge. This impact can be avoided through proper operation of chlorination equipment.

Water conservation measures (section 5.5.5) would be expected to reduce the water supply needs of the city of Norman. Such measures would also reduce the volume of wastewater discharge, which would reduce the potential of the Canadian to provide beneficial uses.

Control of nonpoint sources (section 5.5.6) would help to mitigate the impacts of growth on water quality in runoff and in Lake Thunderbird.

6.2.10 Impacts of EPA Alternatives

Short-term impacts on water resources are mainly those associated with construction of sewer lines (dewatering; siltation). EPA alternatives would not alter these impacts, except that the normal funding process provides an added level of review which helps to ensure that mitigation measures such as those listed in table 5-3 are considered for inclusion in construction contracts.

The major long-term impacts on water resources from growth in the Norman area are: increases in pollutant concentrations in runoff from urbanizing areas, with resultant changes in Lake Thunderbird water quality; changes in the water quality of the Canadian due to improvement of wastewater treatment; and potential degradation of ground water beneath the sludge land-application site. EPA funding to sewer lines may facilitate these changes.

EPA could choose not to fund sewer lines which would serve development in the Little River basin; however, impacts of the scattered development which would occur without provision of sewerage might equal or exceed those of the proposed action. More importantly, this decision could not address urbanization in Moore, which has a much greater impact on Lake Thunderbird than growth in Norman.

Of the four alternative levels of treatment, the higher the level of treatment, the better would be the water quality of the Canadian River. All levels should improve the Canadian's water quality, compared to existing conditions. EPA may fund only the most cost-effective, environmentally sound alternative relating to the treatment level required to meet the NPDES permit effluent limitations.

In order to avoid the potential adverse impacts on ground water from land application of sludge, EPA could choose to fund one of the incineration alternatives. The ash disposal required with incineration might also result in contamination of ground water, but the area affected would be much smaller.

6.3 AIR QUALITY; ODOR; NOISE

6.3.1 Existing Conditions

Air quality. Table 6-10 lists Oklahoma state standards for air pollutants. Primary ambient air quality standards define levels of air quality which are judged necessary, with an adequate margin of safety, to protect the public health. Secondary ambient air quality standards define levels of air quality which are judged necessary to protect the public welfare from any known or anticipated adverse effects of a pollutant. State primary and secondary standards that pertain to Cleveland County are equivalent to federal standards.

Currently, Norman meets all the primary standards listed in table 6-10 (Thorton, 1982). Until recently, Cleveland County was considered a "non-attainment" area for photochemical oxidants, based on the ozone monitor located in Moore. When federal standards for this pollutant were raised from 0.08 ppm to 0.12 ppm, Cleveland County was averaging just below 0.12 ppm and therefore was dropped from "non-attainment" status.

There is a sampling station for particulates in Norman, located at 641 E. Robinson. Readings at this spot for averaged 61.1 ug/m^3 in 1981, versus the state primary standard of 75 ug/m^3. In 1980, the secondary particulate

TABLE 6-10. OKLAHOMA AIR QUALITY STANDARDS AND INCREMENTS.

PRIMARY STANDARDS

	Annual	1 Hour Max.	3 Hour Max.	8 Hour Max.	24 Hour Max.	Calender Quarter
Sulfur Oxides (Sulfur Dioxide)	a/ 80 ug/m^3	-	-	-	b/ 365 ug/m^3 (0.14 ppm)	-
Particulate Matter	c/ 75 ug/m^3	-	-	-	b/ 260 ug/m^3	-
Carbon Monoxide	-	b/ 40 mg/m^3 (35 ppm)	-	b/ 10 mg/m^3 (9 ppm)		-
Photochemical Oxidants (Ozone)	-	e/ 40 mg/m^3 (0.12 ppm)	-	-	-	-
Non-methane Hydrocarbons	-	-	b/ d/ f/ 160 ug/m^3 (0.24 ppm)	-	-	-
Nitrogen Oxides (Nitrogen Dioxide)	a/ 100 mg/m^3 (0.05 ppm)	-	-	-	-	-
Lead	-	-	-	-	.	1.5 ug/m^3

SECONDARY STANDARDS

	Annual	1 Hour Max.	3 Hour Max.	8 Hour Max.	24 Hour Max.	Calender Quarter
Sulfur Oxides (Sulfur Dioxide)		-	1300 ug/m^3 (0.5 ppm)	-	-	-
Particulate Matter	c/ 60 ug/m^3	-	-	.	b/ 150 ug/m^3	-
Carbon Monoxide	-	b/ 40 mg/m^3 (35 ppm)	-	b/ 10 mg/m^3 (9 ppm)	-	-
Photochemical Oxidants (Ozone)	-	e/ 40 mg/m^3 (0.12 ppm)	-	-	-	-
Non-methane Hydrocarbons	-	-	b/ d/ f/ 160 ug/m^3 (0.24 ppm)	-	-	-
Nitrogen Oxides (Nitrogen Dioxide)	a/ 100 mg/m^3 (0.05 ppm)	-	-	-	-	-
Lead	-	-	-	-	-	1.5 ug/m^3

a. Annual arithmetic mean.
b. Not to be exceeded more than once per year.
c. Annual geometric mean.
d. Measured between 6 a.m. and 9 a.m.
e. The standard is attained when the expected number of days per calender year with maximum hourly average concentrations above 0.12 parts per million is equal to or less than 1, as determined by Appendix H for Part 50 of Chapter 1, Title 40 of the Code of Federal Regulations.
f. Guide-only value to EPA, to be used in planning, not a Federal standard.

Source: OSDH 1980b.

24-hour standard of 150 mg/m^3 was exceeded twice with readings of 152 and 154. The cause of these high readings is not known. Particulate excursions are not frequent at Norman; in the period from 1976 to 1981, 1980 was the only year with a reported violation (Thorton, 1982).

No values above the standard for nitrogen oxides have been recorded at the sampling station in Moore. Sulfur dioxide levels state-wide are below the primary standard of 80 ug/m^3 annually (Thorton, 1982).

Odor. Odor sources in the Norman planning area include the Woodcrest emergency detention pond, sewage overflow locations (see figure 5-3) and the treatment plant itself. The detention pond lies between the Sutton Wilderness Park on the north and the Central State Hospital on the south, and is near residences to the east. Odor impacts vary with the weather and with wind direction (which is from the south except in winter, when wind is from the north). While odor complaints still occur, they are less frequent than when the pond was first built in November of 1979. Odors from overflows in the system continue to be a serious problem in the Eastwood Park, Imhoff Creek, and Normandy Creek areas (see also section 6.6.1).

There are odors associated with emissions from the treatment plant tower trickling filter, including humic odors from bacteria in the treatment filters and odors from incoming sewage that has turned septic. The septic condition of incoming sewage is due to surcharging (back-ups) in a major interceptor. A diversion box arrangement near the plant entrance, installed a few years ago, reduced the odor associated with incoming sewage backup. However, this was only intended as a temporary solution and incoming sewage continues to be a source of odor.

The only other odor source of any concern in the planning area is the sewage treatment plant located in Moore. Odor from this facility can be detected in the northern part of Norman and has been the source of complaints in this area (Brown, 1982).

Noise. Noise standards which apply to the planning area are presented in table 6-11. Data characterizing noise in the Norman area indicate that complaints are mostly for barking dogs, motorcycles, loud parties, stereos, and oil wells; no wastewater-related complaints, such as for lift station pumps or the treatment plant, have been noted (Fant, 1982). A study by the Environmental Control Advisory Board (ECAB, 1976) involved measurement and classification of noise in Norman from twenty-four sites collected over a two year period. The report found values ranging from 40+ dB(A) in residential areas (approximately the noise level of indoor residential areas) to 80+ dB(A) along Interstate 35 and other major streets (slightly louder than a freight train at 50 feet). The report concluded that the major impact on Norman's overall noise level is from transportation.

TABLE 6-11. NOISE LEVELS AND GUIDELINES.

Federal Identified Levels: The table below is a summary of noise levels identified as requisite to protect public health and welfare with an adequate margin of safety. L_{eq} represents the sound energy averaged over an 8-hour period ($L_{eq}(8)$) or a 24 hour period ($L_{eq}(24)$). L_{dn} represents the L_{eq} with a 10 decibel (dB) nighttime weighting. The exposure period which results in hearing loss at the identified level is a period of forty years, for a typical eight hour working day.

Effect	Level	Area
Hearing loss	$L_{eq}(24)$ - 70 dB	All areas
Outdoor activity interference and annoyance	L_{dn} - 55 dB	Outdoors in residential areas and farms and other outdoor areas where people spend widely varying amounts of time and other places in which quiet is a basis for use.
	$L_{eq}(24)$ - 55 dB	Outdoor areas where people spend limited amounts of time, such as school yards, playgrounds, etc.
Indoor activity	L_{dn} - 45 dB	Indoor residential areas
	$L_{eq}(24)$ - 45 dB	Other indoor areas with human activities such as schools, etc.

City Ordinance: Summary of Sections 10-301-313, "use district" noise levels and motor vehicles noise. L_{90} is the sound level exceeded 90% of the time; L_{10} - 10% of the time; and L_1 - 1% of the time. A measurement period is from 10 to 30 minutes.

A. Maximum permissible sound levels for a stationary source:
- 15 dB(A) above the ambient sound level (L_{90}) within any land use district, or
- does not exceed the following at the property line affected:

Use District	L90 9 p.m. -7 a.m.	L90 7 a.m. -9 p.m.	L10 9 p.m. -7 a.m.	L10 7 a.m. -9 p.m.	L1 9 p.m. -7 a.m.	L1 7 a.m. -9 p.m.
Residential	50dB(A)	55dB(A)	60dB(A)	65dB(A)	65dB(A)	70dB(A)
Commercial	55dB(A)	60dB(A)	65dB(A)	70dB(A)	70dB(a)	75dB(A)
Industrial	65dB(A)	70dB(A)	75dB(A)	80dB(A)	75dB(A)	85dB(A)

B. Maximum permissible level for general traffic is 78 dB(A).

C. Quiet zone standards are the same as those listed above for residential areas.

Sources: EPA 1974; Fant, 1982.

6.3.2 Impacts of the No Action Alternative

The No Action alternative would fail to solve the existing odor problems associated with the treatment plant, the detention pond, and overflows in the system. It would favor sprawling development in presently rural areas with attendant increases in traffic and thus greater vehicle emissions and noise.

6.3.3 Impacts of Collection Alternatives

Air quality. The proposed interceptors would have no direct, long-term impact on air quality, other than to reduce odors. Dust might be generated at a construction site by soil disturbances and vehicle movement, by wind erosion of excavated material, and by operations such as concrete mixing. Construction dust is a nuisance material which causes annoyance, soiling and, in some cases, impaired local visibility. In order to minimize dust during construction, excavated soil would be exposed for as short a period as practical, and would be left with a rough surface in order to minimize erodibility. If necessary, further dust control would be by watering, use of soil stabilizers, or reseeding as appropriate.

The exhaust from gasoline or diesel-powered equipment is the main source of non-particulate air pollutant emissions at most construction sites. Emissions would be small compared to regional quantities, and would mainly have a localized impact during periods when air ventilation is poor. Fumes and odors might reach an annoyance level, but enforcement of OSHA (Occupational Safety and Health Administration) standards to protect construction workers should protect area residents against health impacts, although annoyance and irritation may occur on a short-term basis.

Impact of growth on air quality. Development resulting from the proposed action would result in compact, higher density residential development near the downtown area and in neighborhood units. This would result in shorter commuting distances than without the proposed action. Therefore, while growth will further increase the amount of pollutants discharged into the air, the proposed action, which would permit higher density development, would enable the increase in pollutants to be less than would otherwise occur.

Odor. The proposed action should greatly reduce the causes of current odor problems. In the Bishop Creek area, the emergency holding pond on 12th Avenue would be removed and the interceptor capacity increased, preventing future overflows due to surcharging in the lines. Reduction of odors would enhance the enjoyment of outdoor activities in this area, especially in the Sutton Wilderness Park, upwind of the holding ponds, and in Eastwood Park where odors from overflows have been a source of complaints. Odors due to surcharging in the lines also occur in the Imhoff Creek area and in the Normandy Creek area near Southwest 24th Avenue at Boyd Street. The proposed action would eliminate odors in this area also. Inadequate on-site systems have caused additional odors, particularly in the vicinity of Highway 9 along

Classen Street and along 24th Avenue; the proposed collection system would eliminate the need for on-site systems in this area.

Noise. Construction noise would probably average between 75-90 decibels (A-Scale) at active sites, with peaks exceeding 100 dBA, since these sound levels would be typical of common construction equipment. The levels would be expected to decrease markedly away from the sites, and should not exceed 55-65 dBA at a distance of 800-1000 feet (about 300 meters); a level of 55 dBA is usually not considered excessive for residential areas during the daytime (see table 6-11). The effects of noise would be limited by restricting construction activity to weekday and daytime periods. In addition, Occupational Safety and Health Administration standards would be adhered to, and no blasting would be required.

There would be a potential for noise to affect wildlife and visitors in Sutton Wilderness Park and the Oliver Wildlife Preserve during construction of interceptor lines. Also, there are several schools and hospitals along the construction routes which may be adversely impacted by noise during the construction period. However, there are no permanent noise sources created by construction of the collection system. Noise associated with lift station operation, runs in the order of 50 dBA (EPA, 1977b) which is acceptable for residential areas (see table 6-11).

6.3.4 Impacts of Treatment Alternatives

Air quality. Construction of new treatment facilities would have impacts comparable to those described for the collection system; i.e., some dust and fumes. The location of the facility near a major Interstate highway should minimize the significance of these impacts on adjacent properties. The only treatment alternative that might harm the air quality is alternative 7. This alternative would involve land application of the wastewater by spray irrigation, with the potential to produce pathogen-containing aerosols.

Noise. Noise levels associated with construction of new facilities would be comparable to those described for construction of the collection system. Operation of the plant would produce noise in the range of 45-55 dBA at the plant boundary (EPA, 1977b). Again, the nearby highway should minimize the significance of any noise generated by the plant.

Odor. Wastewater treatment facilities have the potential to produce odors from several sources. For example, if alternative 4 is implemented, the following measures would be taken to minimize odors. The first cell of the lagoon would be cement-lined and aerated to control odors. Bio-discs do not have a significant potential for odors but they would be covered and this should contain any odors that might occur. Relatively advanced equipment and the addition of chemicals should reduce the organics in the wastewater, sludge, and backwash, which in turn should minimize odors. Sludge holding tanks might be a source of odors only if the sludge inventory is not kept at proper levels and is allowed to build up. The more sludge that is allowed to accumulate, and the older it is, the greater the potential for odor. Proper operation of the treatment plant would avoid such problems. The facilities plan proposes to install a screw pump lift station of sufficient capacity to eliminate back ups of the incoming septic sewage. This measure should reduce tower trickling filter odor. However, it is normal for trickling filters to produce some musty odor.

Odor impacts associated with the other treatment alternatives would be the same as those above, with the following exceptions. Alternative 1 would not use a bio-filter (trickling filter) and so would not have the odor problem associated with it. Alternatives 1, 2 and 3 would be aerated systems; the aeration prevents the anaerobic conditions which produce the obnoxious odors often associated with sewage. The storage lagoon which would be used in alternative 7 (land application) would be a potential source of odor.

6.3.5 Impacts of Sludge Management Alternatives

Air quality. Alternatives 1 and 2 call for trucking the sludge to the disposal site. Emissions from the trucks and disposal equipment would contribute a negligible amount of air pollutants to the vicinity. Both these alternatives call for anaerobic digestion which produces methane, hydrogen sulfide and other gases. Disposal of the digester gas is by combustion, which produces nitrogen oxides, particulates, carbon monoxide, hydrocarbons, and sulfur dioxide. However, the quantity of such emissions would be negligible compared to the total pollutant burden in the planning area. Disturbance of soil at the land application site could result in increased dust from the site; this can be minimized by vegetative cover and wind breaks (see section 6.1.5).

Alternatives 3 and 4 both involve incineration, and thus both have a potential to adversely impact Norman's air quality. Pollution control equipment, such as scrubbers, would be required in order for the incineration process to meet air quality regulations. Table 6-12 lists quantities of sludge incineration emissions, before and after scrubbing, for particulates, sulfur dioxide, carbon monoxide, nitrogen oxides, hydrocarbons, and hydrogen chloride gas. Metals (such as mercury), pesticides, PCB's, and other persistent organics may also be present in incineration emissions; their concentrations would depend primarily on the amount and type of industries contributing to the wastewater and municipal refuse streams, and they should not be significant in Norman.

Most of the above-listed contaminants should not be emitted at significantly high levels if the incinerator is properly designed (EPA, 1980; NRC, 1978). The pollutant of greatest concern is particulates; EPA has set standards concerning particulates from sludge incineration, as follows (EPA, 1980):

1. particulate emissions must be no more than 0.65 grams per kilogram of dry sludge input;

TABLE 6-12. EMISSION FACTORS FOR SLUDGE INCINERATORS.

Sludge incinerators must be equipped with scrubbers to remove particulates and other combustion products. Particulates and gaseous emissions with and without scrubbing are shown here. Levels indicated after scrubbing will not necessarily meet air quality standards.

Neg = negligible. kg/MT = kilograms per metric ton.

	Emissions (per unit of dry solids fired)			
	Uncontrolled		After Scrubber	
Pollutant	lb/ton	kg/MT	lb/ton	kg/MT
Particulates	100	50	3	1.5
Sulfur dioxide	1	0.5	0.8	0.4
Carbon monoxide	Neg	Neg	Neg	Neg
Nitrogen oxides (as NO_2)	6	3	5	2.5
Hydrocarbons	1.5	0.75	1	0.5
Hydrogen chloride gas	1.5	0.75	0.3	0.15

Source: NRC, 1978.

2. the emission plume must be of less than 20 percent opacity;
3. particulate collection equipment must have efficiencies of 96-97 percent.

A standard is also set for mercury emissions: no more than 3200 g/day of mercury may be released (EPA, 1977c).

With alternative 3 (codisposal) there might be short-lived emissions of excessive smoke, should rubber tires or oil get into the incinerator along with municipal refuse. For both incineration alternatives, dust control measures would need to be taken so that the residual ash from incineration would not become airborne during disposal.

Odors. As discussed in sections 5.4 and 6.6.5, the land application site proposed for alternatives 1 or 2 is located such that odors from the site could impact residential areas. However, as the sludge is to be incorporated into the soil, odors are not expected to be significant. There is also some potential for odors from the anaerobic digesters which would used for either alternative; proper operation of the digesters would prevent objectionable odors. There would be no odor from alternative 3 or 4 if the incinerator is properly operated.

Noise. Alternatives 1 and 2 call for trucking the sludge to the disposal site and then using machinery to either inject or landfill the sludge. The trucks and machinery would create noise on the order of 70-80 dBA (at 50 feet). The truck noise (two round trips a day) would not effect a noticable increase in ambient noise levels. Noise at the disposal sites would be in addition to existing sources such as the noise levels from the interstate highway. The turbine that would be used along with alternative 3 (codisposal) would produce considerable noise. Presently, the proposed location for the cogenerator is at the existing plant site. This equipment would be enclosed in a building to reduce noise impact on the surrounding area. If this alternative is selected, it will be designed to conform to appropriate noise regulations.

6.3.6 Impacts of Other Alternatives

For the most part, actions taken with respect to on-site systems, disinfection, energy conservation, water conservation, nonpoint source control, administration, and funding have no impacts on air and sound quality. Those impacts which do occur (e.g. adverse short-term effects from construction of various facilities) would be similar for all alternatives described in section 5.5.

6.3.7 Impacts of EPA Alternatives

The major adverse impacts on air and sound quality would be the short-term effects of project construction and long-term noise and emissions at project facilities. These impacts would be an unavoidable result of the actions which Norman must take if it is to correct existing treatment deficiencies, and provide for orderly urban development. EPA alternatives would not alter these impacts, except that the normal funding process provides an added level of review which helps ensure that mitigation measures such as listed in table 5-3 are considered for inclusion in construction contracts.

6.4 BIOLOGY; ENDANGERED SPECIES

6.4.1 Existing Conditions: Biology

Central Oklahoma presents a unique and diverse biological environment as the boundary area between eastern and western vegetational types. The eastern deciduous forests reach their westernmost limit here; likewise, the western tall grass prairies are at their easternmost extent. This area of transition is termed an ecotone - the "junction zone" or "tension belt" where the two vegetational types and their associated fauna intermix and compete. Because the ecotone is habitat for species of both vegetational types, as well as species peculiar to the ecotone, it tends to exhibit high biological diversity (Johnson, 1957). Norman also possesses a variety of aquatic habitats with the Canadian River to the west, Lake Thunderbird to the east, and numerous ponds scattered throughout the area.

Terrestrial communities in Norman. The distribution of natural biological communities in Norman corresponds approximately to the natural regions discussed in section 6.1.1 and graphically depicted in figure 6-1. Detailed information on these communities is presented in table 6-1.

The bottomland area borders along the Canadian River and, to a limited extent, along portions of streams in the Little River system. Bottomland forests - consisting of oaks, elms and cottonwoods, with grass understory - provide habitat for various mammals, reptiles, amphibians, and birds. Fallen cottonwoods provide excellent microclimates for many invertebrates. Much of the bottomland area is now pastureland. Bottomland soils are the most fertile for agriculture in Cleveland County.

Approximately 80 acres of mostly bottomland terrestrial community is preserved by the University of Oklahoma as a wildlife sanctuary and field study area. The parcel, commonly known as Oliver Wildlife Preserve, adjoins the existing treatment plant (refer to figure 6-7). The preserve is unique in that it is in late successional (nearly natural) stages of growth, having passed from grassland to cottonwood to juniper and oak to elm and hickory. The preserve is divided northeast to southwest by a 30 to 40 foot bluff creating both an uplands forest habitat and a bottomlands habitat. The preserve contains an abundance of wildlife, including many species of birds, reptiles and small mammals, plus deer, skunk, oppossum, coyote and other large mammals.

The tallgrass prairie area is a tongue of western grassland extending down into Cleveland County parallel to the Canadian River. Native vegetation consists predominately of little bluestem, big bluestem, side-oats grama, and buffalo grass. Most of urbanized Norman falls within this area, and much of the area is used as pasture or cropland. The impervious Hennessey shale underlying much of the prairie makes it well suited to hold water (Soil Survey Series, 1942); many small ponds exist on private land and are used for livestock and recreation.

The postoak-blackjack association begins abruptly about three miles east of urbanized Norman with a boundary running roughly north-south. It is similar to eastern deciduous forests. As the name implies, the dominant species are postoak and blackjack, with some black hickory. Originally the forest consisted of stands of mature trees with grass ground cover, but most of the area has been disturbed and now consists of dense scrubby oak growth with sumac and other shrubs and vines. Early attempts at agriculture were mostly unsuccessful, and numerous old fields stand in various stages of succession back to natural vegetation. Lake Thunderbird has attracted various migratory waterfowl and shoreline wildlife in this area.

Aquatic communities. Several types of aquatic communities exist in Norman, and are briefly described below. More detailed information on the species to be found in the Little River and Lake Thunderbird is provided in LWA (1982a).

The Canadian River supports several species of fish (most notably red shiner), phytoplankton (algae), and macrobenthos (invertebrates). However, the suitability of the Canadian as a fishery is severely limited by several factors such as: periods of very low flow (the seven-day two-year low flow is zero); wildly fluctuating flows; and very high water temperatures - as much as 100° F (ACOG, 1981a).

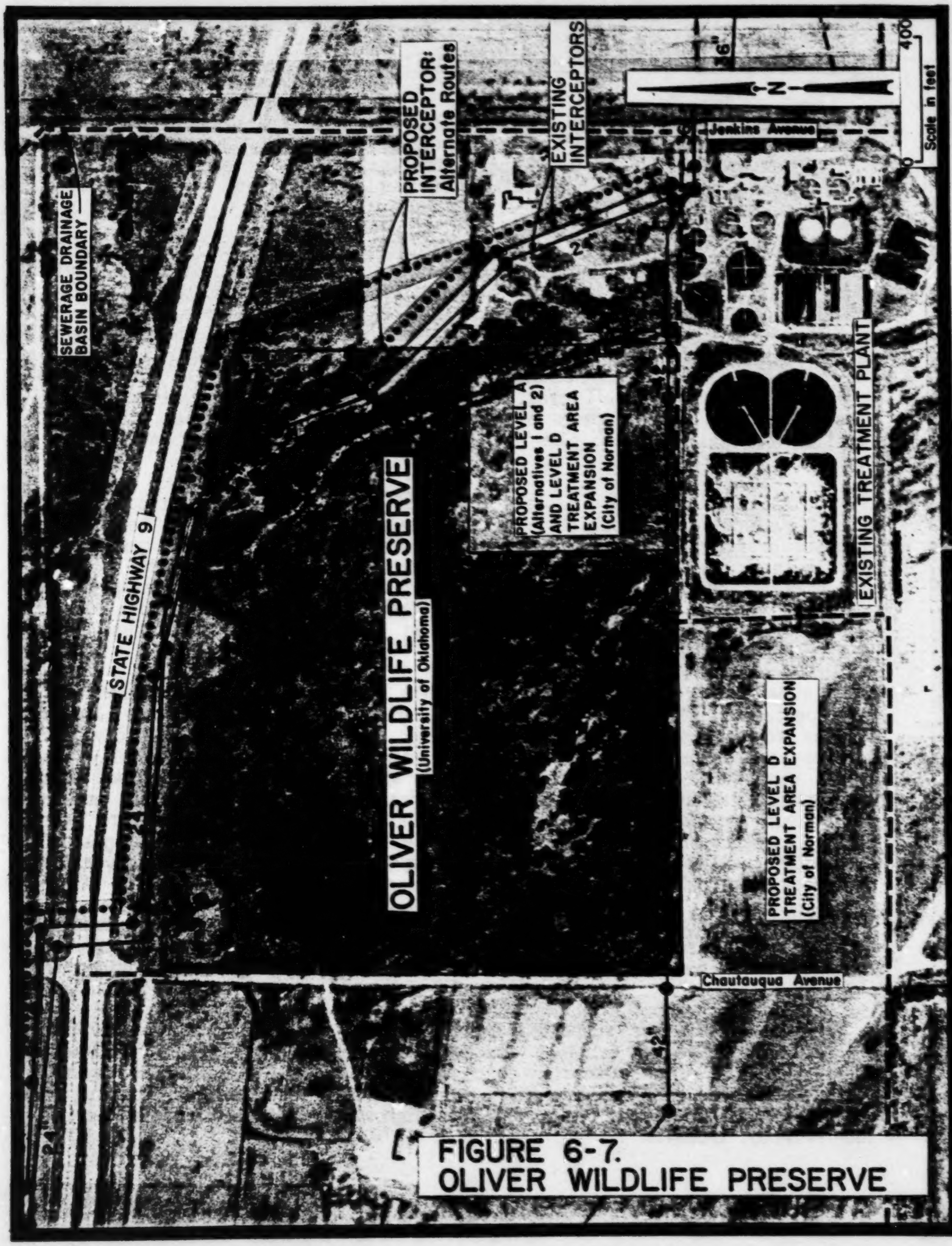

SEWERAGE DRAINAGE BASIN BOUNDARY
STATE HIGHWAY 9
PROPOSED INTERCEPTOR: Alternate Routes
EXISTING INTERCEPTORS
OLIVER WILDLIFE PRESERVE
(University of Oklahoma)
PROPOSED LEVEL A (Alternatives 1 and 2) AND LEVEL D TREATMENT AREA EXPANSION (City of Norman)
EXISTING TREATMENT PLANT
PROPOSED LEVEL D TREATMENT AREA EXPANSION (City of Norman)
Jenkins Avenue
Chautauqua Avenue
N
0
400
Scale in feet
36"
42"
24"

FIGURE 6-7.
OLIVER WILDLIFE PRESERVE

At present, the Canadian is designated by the Oklahoma Water Resources Board as a "warm-water fishery". Water quality standards to maintain this use require that dissolved oxygen levels average 5 mg/l, and that they not fall below 4 mg/l. However, even if these standards could be met, it is not certain that the Canadian could support much of a fishery, for the reasons listed above. Therefore, ACOG has recommended that the Canadian be designated a "secondary warm-water fishery". This designation would recognize that under critical conditions, fish propagation would be inhibited below wastewater discharge points.

The streams of the Little River system are relatively sterile in terms of species abundance, but they do support several kinds of fish and a limited benthic fauna (mostly insect larvae).

Many ponds dot the map in Cleveland County. These are nearly all on private land and are used for livestock watering and recreation. Ponds on farms receive a large supply of nutrients and can support abundant phytoplankton (algae) populations. Fish, such as channel catfish and largemouth bass, provide sport. Ponds are also important to birds which feed on the insects which breed there. Migratory shorebirds gather around ponds to feed on the fish.

The creation of Lake Thunderbird has provided a major aquatic habitat in the Little River basin. Fish and aquatic birds have increased in number, as has species diversity. Phytoplankton, zooplankton, and benthic fauna living in the lake support a variety of fish, including species stocked for sport fishing. Macrophytes (large plants) on the shoreline provide food and habitat for a variety of animals. Central Oklahoma is a flyway for migratory shorebirds, many of which are attracted to land at impoundments such as Lake Thunderbird.

The biological composition of Lake Thunderbird is consistent with the lake being warm, turbid, alkaline, and moderately eutrophic. Recent review of the biological data available for Lake Thunderbird indicate that blue-green algae with nuisance potential have been dominant or co-dominant in at least fifty percent of the samples taken (LWA, 1982a). Anabaena and Microcystis are the most common blue-green species. At other times Melosira, a centric diatom, is dominant. Other diatoms and flagellates are also commonly found. Chlorophyll a levels in the lake range from 3.5 to 18 ug/l, the average being about 15 ug/l.

6.4.2 Existing Environment: Endangered Species

In accordance with Section 7 of the Endangered Species Act, as amended, the U.S. Fish and Wildlife Service (USFWS) was contacted to identify any plant or animal species or habitats that are listed or proposed for listing as endangered or threatened within the Norman area. The USFWS sent a letter to EPA in 1979 which indicated that no threatened or endangered species nor critical habitats are in Cleveland County; a copy of the letter is in appendix C. That the contents of that letter are still valid was confirmed in a recent conversation with USFS (Bowman, 1982). The Oklahoma State Department of Wildlife Conservation points out that there is a remote chance of finding whooping cranes or peregrine falcons in Cleveland County, since these birds have flyways over the area. There is also some possibility that bald eagles might winter at Lake Thunderbird; a bald eagle was sighted on the South Canadian River in Cleveland County in January, 1982 (Moser, 1982).

6.4.3 Impacts of the No Action Alternative

Under the No Action alternative, wastewater effluent of increasingly poorer quality would be discharged into the South Canadian River. This would result in lowered dissolved oxygen levels, with consequent adverse impacts on the aquatic ecology. Species diversity in the river would probably decrease (i.e., marginal species would be eliminated), and fishkills might occur.

Impacts on the biology of Lake Thunderbird due to extension of sewer lines into the Little River basin are discussed below (6.4.4). Insofar as lack of sewerage discourages development in the Little River basin, such impacts would be lessened. However, under the No Action alternative, population increases in the Little River basin might be as great, but with development more scattered. In that case, pollutant loading to Lake Thunderbird might increase (because of more road development; pollutants from on-site systems, etc.), so that impacts on the lake ecology would also be greater.

6.4.4 Impacts of Collection Alternatives

Construction impacts. Construction of collection facilities would have limited, short-term impacts on the biological environment. Depending on the specific route chosen for laying new sewer lines, some trees along Bishop, Imhoff and Normandy Creeks may be removed; however, removal of trees would be avoided if at all possible. Siltation from construction activities, which is expected to be minor and insignificant, may impact the habitats of any organisms that might inhabit the bed or banks of those creeks, forcing such organisms to relocate.

The Oliver Wildlife Preserve may be impacted by installation of a 30-inch interceptor (line B-1) along the preserve's northern and eastern edges (figure 6-7). The proposed interceptor would parallel two existing 24-inch interceptors and, on the north side, State Highway 9. Thus, the line would be laid in or adjacent to the highway right-of-way on the north, minimizing construction impacts. Previous lines (laid in 1964) have cut across the northeast corner of the preserve. To avoid disrupting this area again (which has since matured considerably), an alternative route could be chosen which would continue the line east past the corner of the preserve, and then south to the plant; such a route would be preferred by the University of Oklahoma (Carpenter, 1982).

Mitigation of the adverse construction impacts can be accomplished by: careful marking of the construction site, with prohibition of activity outside designated areas; protection of trees outside of the right-of-way; storage of topsoil, and replacement of same atop the completed trench; use of removed vegetation as a mulch on the bared soil to help protect it from erosion and to provide seeds and nutrients for regrowth; no use of pesticides, herbicides or defoliants; and reseeding of sites with native grasses which can be readily established without substantial outside sources of water.

Impacts of growth. Extension of sewers into the Little River basin would facilitate development in the area. Section 6.2.6 discusses increases in runoff pollutant concentrations that are expected to occur as a result of urbanization. Concentrations of ammonia, metals and biochemical oxygen demand are projected to be at levels which may be harmful to aquatic life in the streams receiving the runoff. The small amount of information available indicates that streams in the Norman area support only a limited fauna. Based on this, the impact of growth in Norman would be minor.

Section 6.2.6 discusses potential increases of algal growth (as represented by chlorophyll a) in Lake Thunderbird as the result of increased loadings of phosphorus. It is a possibility that algal growth would be stimulated to the point that algal blooms would reach nuisance proportions. Decay of such blooms would deplete dissolved oxygen in the lake, perhaps to the extent that fish kills would occur. This in turn would have adverse impacts on birds and other wildlife that depend on lake fish for food. As explained in 6.2.6, it is not certain that such impacts will occur, since algal growth in Lake Thunderbird is limited by turbidity, which would also increase.

6.4.5 Impacts of Treatment Alternatives

Terrestrial habitat. Table 6-19 (p. 6-77) lists the land requirements for the various treatment alternatives. Alternatives requiring additional land would result in long-term adverse impacts to biological habitats. Treatment level A alternatives 1 and 2 would require the addition of 10 acres of bottomland habitat to the existing treatment site (figure 6-7). The acreage would be used for emergency stormwater holding ponds and, thus, would result in permanent loss of the acreage. The acreage in question has been grazed until recently, and is now unused. Level A alternatives 3 and 4 and level B and C alternatives do not require additional land and, thus, would involve no construction impacts to native vegetation.

Level D would involve use of the 10 acres mentioned above plus an additional 15 to 20 acres for decant ponds. The additional acreage belongs to the city of Norman, and is unused, grass-covered bottomland. Use of this land would eliminate its availability as a habitat for birds, reptiles and small mammals.

Alternative 7 (land application) would require 640 acres of land for the wastewater storage lagoon, eliminating that size area as a habitat for burrowing mammals and reptiles. However, the lagoon would probably be beneficial to birds and other wildlife that would drink the water or feed on insects that breed in water.

Aquatic habitat. Section 4.3 discusses the alternative treatment levels ACOG assessed in developing wasteload allocations (see especially table 4-3). The primary criterion for evaluating the various levels was whether they would result in dissolved oxygen levels that would protect the Canadian as a warm-water fishery. ACOG's modeling indicated that treatment level 3a (facilities plan level C) would be necessary to meet this criterion (see table 6-9). However, for the reasons listed in section 6.4.1 (intermittent flows; high temperatures), upgrading of water-quality would not ensure much improvement of the river biology during low flows.

Inspection of table 6-9 indicates another limitation on aquatic biology in the Canadian. Even with the most stringent level of treatment (level D), modeled ammonia concentrations are far in excess of the state planning standard of 0.2 mg/l. Thus, even if dissolved oxygen levels meet standards, fish species that are sensitive to ammonia toxicity probably could not survive in the Canadian during low flow periods.

Achievement of level A treatment would improve the water quality of the Canadian over existing conditions. Thus, the aquatic life in the river should experience improvement (both in numbers and species diversity). The aquatic biology would suffer somewhat during low-flow periods; however, note that without the wastewater discharge, there would be no flow whatsoever during such periods, and thus no aquatic biology.

6.4.6 Impacts of Sludge Management Alternatives

Implementation of land application for sludge disposal (alternative 1 or 2) would lead to removal of native vegetation from 205 to 275 acres of land (assuming level A treatment), and would destroy any wildlife habitat in that area. However, sludge application would improve the ability of the soils to support vegetation. The facilities plan proposes to utilize the nutrient value of the sludge by cultivating crops such as alfalfa at the disposal site. Alternatively, habitat loss at the site could be mitigated (and erosion problems reduced) if strips of the natural vegetation and soil are left undisturbed; this would create a more varied environment for the wildlife of the area, as well as a windbreak.

The incineration alternatives (3 and 4) would require landfill of ash; 4 to 20 acres of vegetation and habitat would be disturbed over the 20-year period. If level D treatment is implemented, another 60 acres of land will be required for disposal of chemical sludge, no matter which sludge management alternative is implemented. Again, this would disturb vegetation and wildlife habitat at the landfill site.

6.4.7 Impacts of Other Alternatives

For the most part, actions taken with respect to on-site systems, energy conservation, odor control, water conservation, administration, and funding have no impacts on biology. Those impacts which do occur (e.g. from construction of various facilities) are the same for all alternatives described in section 5.5. Implementation of nonpoint-source control (5.5.6) would help to mitigate the growth-related impacts described above (6.4.4).

6.4.8 Impacts of EPA Alternatives

The major adverse, short-term impacts on biological resources result from construction of interceptors and new wastewater facilities. Beneficial, long-term impacts on aquatic life would result from improvements at the treatment plant. The use of a sludge application site would have adverse, long-term impacts by removing natural vegetation from a large area. EPA alternatives do not alter these impacts, except that the normal funding process provides an added level of review which helps ensure that mitigation measures such as listed in table 5-3 are considered for inclusion in construction contracts. In addition, funding can be conditioned to insure that no significant impact occurs; for example, EPA can condition its funding to require that interceptor construction bypass Oliver Wildlife Preserve.

6.5 ARCHAEOLOGICAL AND HISTORICAL RESOURCES

6.5.1 Existing Conditions

Human entry into central Oklahoma appears to have occurred about 9,000 years ago, as Paleo-Indian hunter-gatherers. Passage from hunting and gathering towards agriculture occurred during the subsequent Archaic Period, which is not well defined but probably covers at least the last 7,000 years B.C. By 1000 A.D. Woodland cultures were evolving the settled patterns of life that marked the Plains Village Period. However, many small settlements that flourished along the western plains riverbanks were abandoned by 1500 A.D. When the Spanish arrived in the 1500s they found Kiowa, Kiowa-Apache and Comanche "Plains Indians" established, with traditional hunting and gathering ways. Spanish and French explorations and control in the 16th, 17th, and 18th centuries were superficial and left little trace, but events during the 19th century included acquisition of the area by the U.S. as part of the Louisiana Purchase, resettlement of Indians from the southern U.S. into central Oklahoma, opening of the area to homesteading, and the discovery of oil. Norman and five other townsites, including Oklahoma City, were established during the land rush of 1889. Statehood followed in 1907.

The State Historic Preservation Officer (SHPO) and the State Archaeologist were contacted in summer of 1981 for identification of archaeological and historic sites in the project area. They indicated that there are no known sites that are on, or eligible for, the National Register of Historic Sites or the list maintained by the state. Since the first contact, the facilities plan was altered somewhat, and so the SHPO and State Archaeologists were again contacted in spring of 1982. Again, no sites were identified; however, the State Archaeologist indicated that some of the sludge disposal sites and the land application site would need surveys prior to construction activities. The State Archaeologist will be notified when a final selection among the alternatives has been made. Appendix C contains copies of the letters from the SHPO and State Archaeologist.

6.5.2 Impacts of the No Action Alternative

There would be no impacts to archaeological or historical sites under the No Action alternative.

6.5.3 Impacts of Collection Alternatives

There are no known archaeological or historical sites that will be impacted by the proposed action; see appendix C.

The proposed interceptors will be routed through existing and proposed utility easements. Where lines are projected to cross previously undisturbed areas, archaeological sites may be encountered. Prior to construction of routes in undeveloped areas, rights-of-way should be staked out and inspected by a qualified archaeologist. If sites are found, provision should be made for either mechanical or manual testing, [illegible] required by the archaeologist, so that eligibility for the National Register of Historic Places may be determined, and any further necessary mitigation measures may be defined. Additionally, if any significant resources are identified during construction, work would be halted; EPA, the State Historic Preservation Officer and State Archaeologist would be contacted; and the Advisory Council for Historic Preservation would be afforded an opportunity to comment, if appropriate. The Interagency Archaeological Services would be notified, pursuant to the Archaeological and Historic Preservation Act (section 3).

It is anticipated that the routing of lines will be flexible within limits. If archaeological resources are found during the surveys, minor rerouting would be feasible.

6.5.4 Impacts of Treatment Alternatives

No known archaeological sites occur within the area which would be affected by facilities construction; major sites would not be expected. Should any resources be discovered during construction, work would be halted until the cultural significance of the materials can be determined and compliance with all applicable laws and regulations can be assured.

6.5.5 Impacts of Sludge Management Alternatives

Impacts on archaeological and historical sites are the same as those discussed for the treatment plant, section 6.5.4.

6.5.6 Impacts of Other Alternatives

Actions taken with respect to on-site systems, disinfection, energy conservation, odor control, water conservation, other pollutants, administration, and funding would have no impact on archaeological or historical resources.

6.5.7 Impacts of EPA Alternatives

No adverse impacts on archaeological or historical resources are expected to result from construction of interceptors, improvements at the treatment plant, or use of the disposal sites. If any sites are found, the site would either be avoided or other appropriate mitigation measures employed. Any unavoidable effects which may occur would be a necessary result of the actions which Norman must take if it is to correct existing treatment deficiencies, and provide for orderly urban development. EPA alternatives do not alter these impacts, except that the normal funding process provides an added level of review which helps ensure that mitigation measures such as those listed in table 5-3 are considered for inclusion in construction contracts.

6.6 SOCIO-ECONOMICS AND LAND USE

6.6.1 Existing Conditions

Current land use patterns. The city of Norman contains 186 square miles. Approximately 175 were annexed in 1961 to gain planning control over the Little River watershed. Existing land uses are shown in figure 6-8. The urban and urbanizing portion of the city consists of about 25 square miles. The rest of the land is in rural uses, except for scattered residential subdivisions and the Little Axe settlement east of Lake Thunderbird (ACOG, 1977a). Most urbanization has occurred in the South Canadian River watershed, while urban development in the Little River watershed has been limited. Within Norman, less than 1 square mile of the Little River watershed is developed in medium-density residential or higher use, and another 16 square miles in low-density residential uses; together this is less than 13 percent of the drainage within the Norman municipal limits.

In urban Norman, most land is in residential use, predominantly single-family, with major commercial uses in the downtown/university area and to the west along I-35. Industrial areas are clustered around the airport at the north end of town between I-35 and U.S. 77 and to the south where SH 9 and US

77 intersect. Major institutional uses are the University of Oklahoma and Central State Hospital.

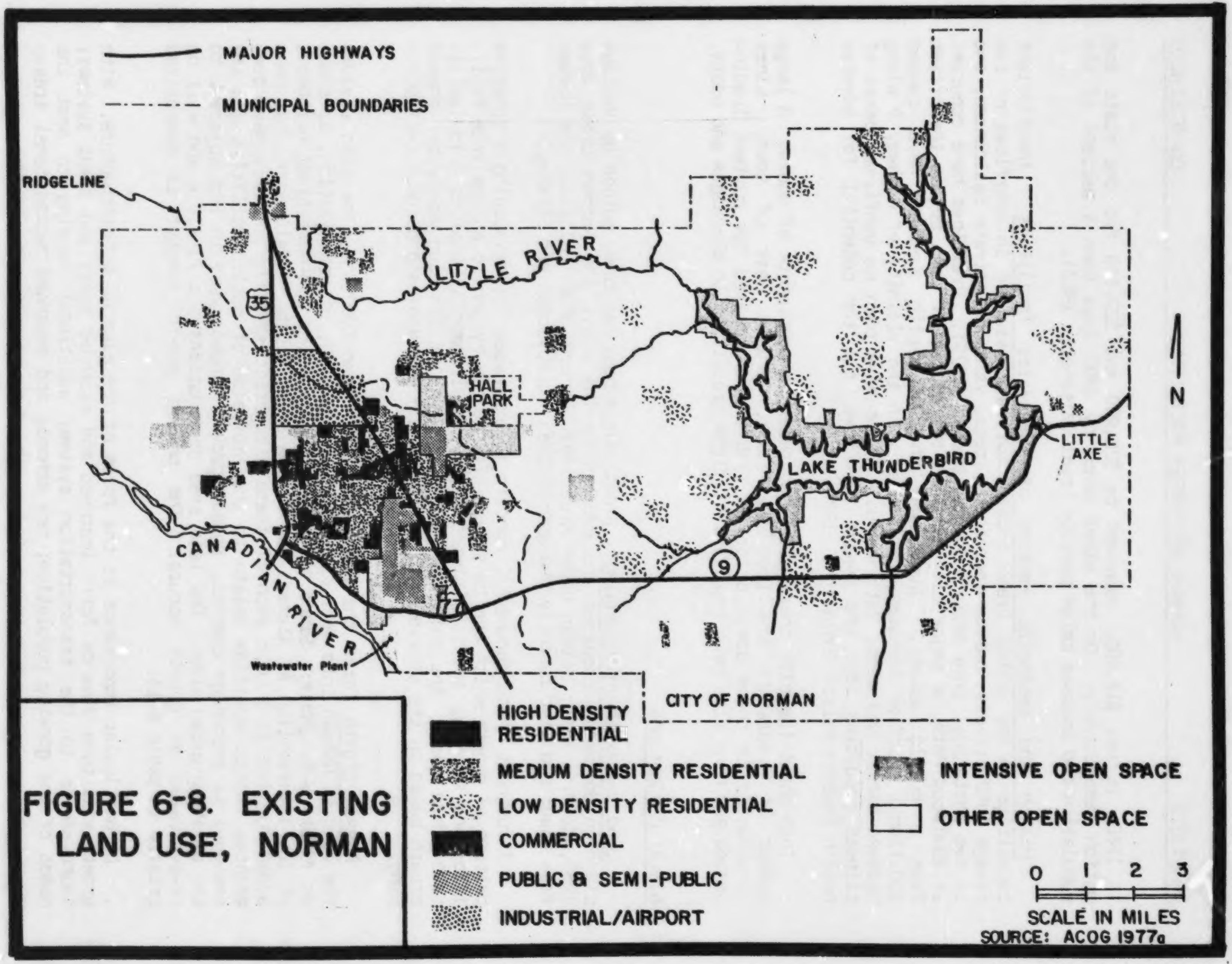
In the vicinity of the treatment plant and the two proposed disposal sites, the land is predominantly open and sparsely vegetated. Specific land uses consist of the Oliver's Woods Wildlife Preserve located directly northeast of the treatment plant, a residential area located north of the proposed disposal sites and some industrial development adjacent to the proposed sludge disposal area. Highway 77 also bisects the sludge disposal site.

Special land uses in Norman which could be affected by the proposed action include: 1) Oliver's Woods Wildlife Preserve, discussed in section 6.4; 2) Sutton Woods Wilderness Area, discussed in section 6.3.3; 3) agricultural lands, discussed later in this section; and 4) Little River State Park. Little River State Park surrounds Lake Thunderbird in the eastern part of town, see figure 6-8. This park provides a variety of outdoor recreational activities including camping, picnicking, hunting, fishing and water-based sports. This park not only serves Norman residents but is also the only regional park with significant camping and water-related facilities serving the Oklahoma City area.

Population. Norman and Cleveland County have experienced substantial population growth over the past several decades, stimulated by expansion of the University of Oklahoma and other government institutions, development of local industries, and proximity to the rapidly growing Oklahoma City metropolitan area. Between 1940 and 1970 the population increased from 11,429 to 52,117. By 1978 the population was estimated at 74,056; the 1980 census revealed the population to be somewhat less: 68,020. The residents of Norman are relatively young, well-educated, and affluent; the percentage of ethnic minorities is low and there is nearly a balance between native Oklahomans and those born elsewhere (USBC, 1970).

Economic conditions. Norman has a healthy economy, with projections indicating continued growth (ACOG, 1972). Traditionally, the economic base of the community has been provided by the University and State Hospital, which in 1970 still provided 30 percent of the area employment. Other important sectors have been services, trade, and to a more limited extent, agriculture. Since World War II the economic base has diversified and now manufacturing and construction also contribute significantly to the area economy. In addition, Oklahoma City provides jobs for Norman's work force, 22 percent of whom worked outside the county in 1970.

Norman's unemployment rate compares favorably with the national rate. In 1970 it was 4.4 percent compared to 4.9 percent for the nation; in 1980, 4.8 compared to 7.1 percent. Although median-family incomes were lower than national averages in 1970, $8,940 versus $9,586, they were higher than the state average of $7,720. The percentage of families in Norman below poverty level was about 9.5 percent. During the past decade, Norman's average household income grew somewhat more slowly than state and national figures.


MAJOR HIGHWAYS
MUNICIPAL BOUNDARIES
RIDGELINE
LITTLE RIVER
35
HALL PARK
LAKE THUNDERBIRD
LITTLE AXE
N
CANADIAN RIVER
Wastewater Plant
9
CITY OF NORMAN
HIGH DENSITY RESIDENTIAL
MEDIUM DENSITY RESIDENTIAL
LOW DENSITY RESIDENTIAL
COMMERCIAL
PUBLIC & SEMI-PUBLIC
INDUSTRIAL/AIRPORT
INTENSIVE OPEN SPACE
OTHER OPEN SPACE
0
1
2
3
SCALE IN MILES

SOURCE: ACOG 1977a

FIGURE 6-8. EXISTING LAND USE, NORMAN

In 1980, it was $18,600, compared to $20,900 and $22,150 for the state and nation respectively. On the other hand, by 1980 less than 5 percent of the population had incomes below poverty level (Mitchell, 1982).

Health and aesthetic aspects of wastewater facilities. Insufficient capacities in the Bishop Creek interceptor have resulted in overflows of raw sewage into streets, public recreation areas, yards of private residences, and in two instances, into private homes (Baxter, 1979). Overflows have occurred at Eastwood Park, a major city park in the center of town across the street from a public school. Inadequate on-site septic systems have caused additional overflow problems, particularly in the vicinity of Highway 9 along Classen Street and along 24th Avenue. There have been no confirmed cases of illness resulting from the sewage overflows, but the potential for adverse health impacts exists (Helmright, 1980).

Throughout the city there have been numerous complaints of odors. A large number of complaints are from the older, central part of town. Lines constructed in these areas prior to 1950 are undersized for current loading demand and many also have insufficient slope, resulting in blockages and odors.

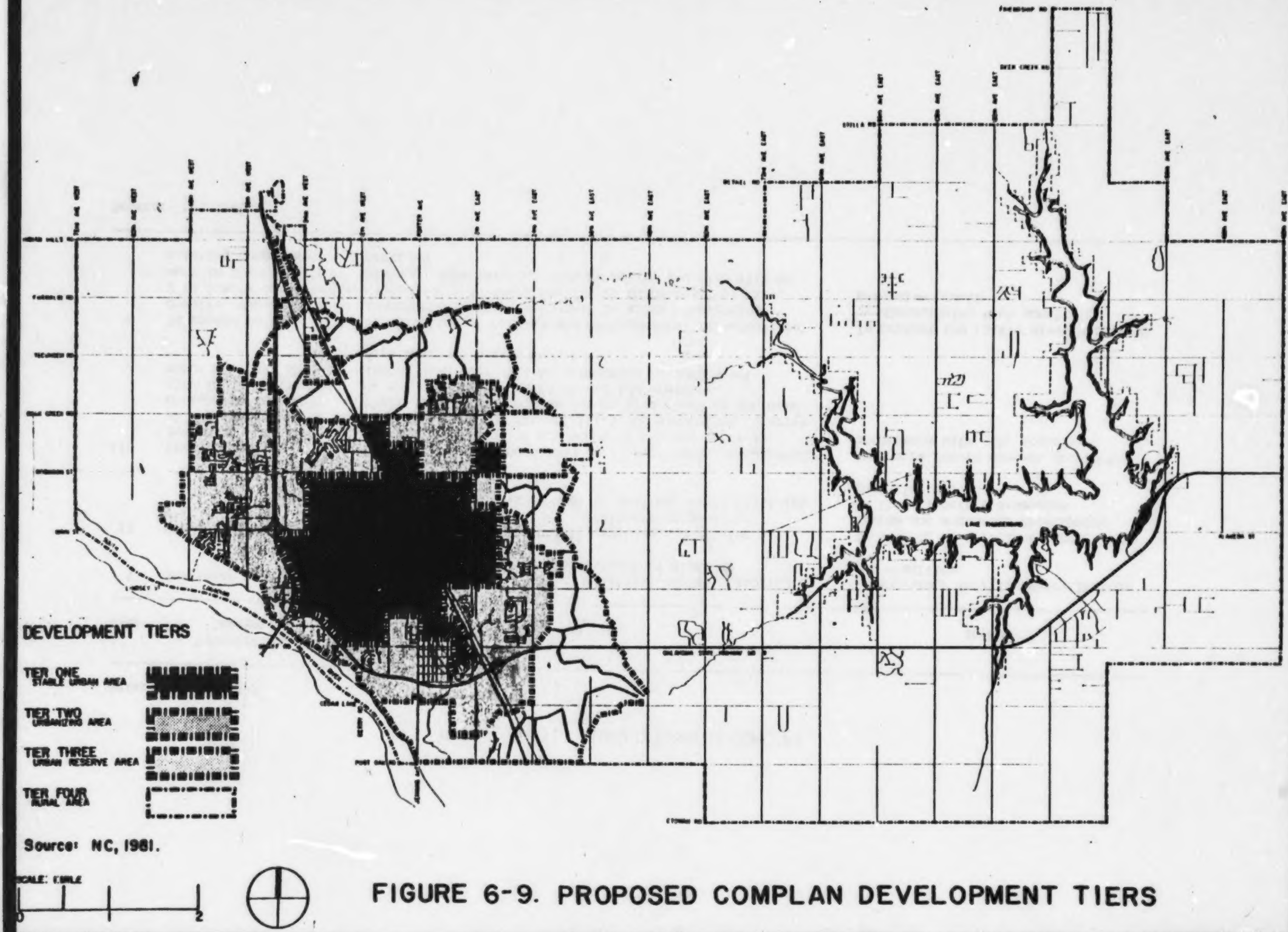
6.6.2 Projections

Land use documents/planning. Growth in Norman has been guided by various planning documents prepared and adopted by the city: the Norman Urban Area 1985, General Plan; Norman Urban Area 1985, General Plan Policies; the Norman Area Plan; and most recently the Norman COMPLAN: Policies and Strategies.

Throughout these documents, concern is expressed for developing a cohesive pattern of growth which can be served efficiently by public and private facilities and services and to minimize adverse environmental impacts. To facilitate these goals, the city has adopted two major planning concepts: phased growth based on the provision of public utilities; and neighborhood unit planning.

Phased growth forms the basis for the Norman COMPLAN. The plan divides the land in Norman into four categories, or "Tiers", of urbanization, as shown on figure 6-9. [Note: Since the map was prepared, a 160-acre tract northeast of the intersection at Alameda and 24th avenue, south of Hall Park, has been added to Tier II.] For each of these categories specific policies have been adopted. Major policies relate to the provision of public utilities and are designed to encourage compact, phased growth concentrated in and adjacent to the existing urban area. The land area designations are flexible and will be re-evaluated as growth occurs. The phased growth concept is summarized briefly in table 6-13.

Of particular importance is the focus of the plan on infrastructure. With growth will come demands for: improved and expanded water and sewer systems; improvements to the transportation system; additional housing to meet the needs of the growing population; new schools and expanded recreational areas;


DEVELOPMENT TIERS
TIER ONE STABLE URBAN AREA
TIER TWO URBANIZING AREA
TIER THREE URBAN RESERVE AREA
TIER FOUR RURAL AREA
SCALE: 1 MILE
0
1
2

Source: NC, 1981.

FIGURE 6-9. PROPOSED COMPLAN DEVELOPMENT TIERS

TABLE 6-13. PHASED GROWTH CONCEPT.

Refer to Figure 6-9

Tier	Urbanization Category	Major Policies	Intent
I	Developed area	City to provide all public utilities; highest priority for construction of new infrastructure elements	To encourage infill, rehabilitation and stability
II	Urbanizing area	City to design public utility systems and provide major elements of systems, developers to provide utility systems that connect to publicly owned utilities	To develop an efficient public works system and encourage development in Tier II before expansion into Tier III
III	Transition area projected to urbanize; will convert to Tier II designation as inner city land is absorbed about the year 2000	City policy is to hold land for future urban development; however, urbanization may occur if the developer is willing to provide all utilities and extensions to serve their site, sized to meet future area needs as approved by the city; if required to provide oversized lines, developer will be reimbursed by subsequent developers as growth occurs	To insure future compact growth in accordance with city policies
IV	To remain in low density, rural use with 2 to 5 acre lot development in the vicinity of existing development	Conservation of natural and environmental resources; to concentrate rural development in areas of existing development; no sewer facilities to be built by city, although some services such as police and fire will be provided	To protect the Little River watershed by discouraging high density or extensive growth

Source: NC, 1981.

more energy resources; staffing and equipment additions for police, fire and health-related services. A major concern is that these required infrastructure items be provided in a phased and coordinated manner which not only maximizes the use of public monies available for infrastructure expansion, but also provides services as they are needed to meet the needs of the growing population. The COMPLAN forms the basis for the extension of infrustructure into developing areas. The wastewater facilities plan, as well as the planned water improvements and 5-Year Capital Facility Plan are designed to provide coordinated, timely provision of services in accordance with the COMPLAN.

The second major concept, the neighborhood community unit, is designed to encourage balanced growth, maintain open space, and reduce commuting (thus reducing noise, air pollution and energy use). This concept provides for a balance of different but complementary land uses within each square mile of the developing urban area (table 6-14). Each neighborhood is planned to accommodate 5,000 to 10,000 people with an average, based on current development patterns, of 7,500. Neighborhood plans have been prepared and finalized for the sixteen community areas projected to develop in the next 20 years.

Land use regulations and enforcement. The city's growth policies are enforced through zoning and subdivision regulations and city policies for the provision of public services. For example, the approach toward maintaining rural land in the Little River watershed includes large-lot and agricultural zoning, a policy against provision of urban-scale services and utilities in Tier IV, and a policy to encourage any new development to locate in the vicinity of existing developments. The enforcement measures are not completely successful, as illustrated by continued scattered development in the watershed and the emphasis on development of single-family houses in neighborhood areas.

TABLE 6-14. DIVISION OF A TYPICAL PLANNED RESIDENTIAL SECTION BY MAJOR LAND USE CATEGORIES

LAND USE CATEGORIES	Percent
Commercial	3.1
Multi-Family	30.0
Single-Family	30.0
Streets	20.0
Quasi-Public	3.1
Parks, Open Space, Schools	13.8
	100.0

Source: EPA, 1977a.

Current land use trends. The steadiest direction of growth in Norman is to the west of I-35, where major shopping centers and low-density (2 acres per unit), single-family homes are being built. Most land designated for urban use to the west will probably be absorbed during the early years of the study period (Frasier, 1981). Rapid growth is now occurring to the southeast, where higher density, single-family uses are being developed. Very little growth has occurred to the northeast, which is presently within the Bishop Creek moratorium area. Some low-density development (2 to 5 acres per unit) utilizing septic tanks, could occur in this area, but low densities are inconsistent with the proposed COMPLAN, and developers have preferred to hold on to the land to develop it at higher densities in the future (Frasier, 1981). Most new industries are locating north of town although one, Shaklee, has built a plant near the intersection of U.S. 77 and SH 9. In the rural areas there is continued subdivision and construction activity occurring randomly.

Trends in neighborhood and commercial growth are not fully in compliance with city plans. Demand is greatest for single-family housing; frequently only the single-family zone has developed within the square-mile neighborhood unit, resulting in a dispersed pattern of development in the urbanizing area which is placing undue stress on the city's infrastructure. In the past few years, however, the demand for higher-density land uses has accelerated and it appears that open land in the partially completed neighborhood areas will be filled in, so that neighborhood units will function efficiently as originally planned (Clark, 1981).

Another concern to city planners is that the commercial development occurring in the west is weakening the vitality of the downtown area (Frasier, 1981). A more balanced growth pattern centered around the downtown area, as called for in the COMPLAN, would tend to stabilize the downtown commercial area's decline. However, the relocation of commercial development is not only following the current shift in the population center but is also relocating along major transportation routes. As a result, the west side is likely to continue to be a favored location for commercial uses due to the availability of access and the proximity of I-35, even if the city's population growth were redirected towards the northeast.

Population projections. Population forecasts developed for the water quality management (208) planning process by ACOG (Association of Central Oklahoma Governments) indicate continued growth in Norman. The forecast is 112,000 residents by the year 2000. This would be an average annual growth rate of 3.2 percent, although growth is expected to occur at a faster rate during the first 10 years and then to slow down. The projections have been approved by the Oklahoma State Department of Health and EPA.

Table 6-15 presents population projections for the city by sewer service drainage basin. The maximum population potential of each area ('total holding capacity'), under current zoning regulations, is also given. In order to develop table 6-15, the 1978 population by basin was determined from a count of housing units. The year 2000 population was then distributed by basin

TABLE 6-15. POPULATION BY SEWER SERVICE BASIN - NORMAN, OKLAHOMA.

Refer to Figure 5-1 for location of basins.

Basin	Existing Population	Undeveloped Holding Capacity	Total Holding Capacity	Projected Population 1990	Projected Population 2000	Projected Increase (1980-2000)
S. Canadian R. Watershed						
A	7,468	22,866	30,334	21,565	22,204	14,736
B	29,846	953	30,799	30,716	30,726	880
C	28,579	19,711	48,290	34,177	35,527	6,948
Subtotal	65,893	43,530	109,423	86,458	88,457	22,564
Little River Watershed						
D	3,690	30,401	34,091	8,482	9,483	5,793
E	580	10,295	10,875	2,619	3,164	2,584
F	143	1,321	1,464	324	334	191
G	998	28,745	29,743	4,325	5,360	4,362
H	2,752	37,090	39,842	4,992	5,202	2,450
I	0	117	117	0	0	0
Subtotal	8,163	107,969	116,132	20,742	23,543	15,380
TOTAL	74,056	151,499	225,555	107,200	112,000	37,944

Source: PSC, 1981.

using zoning densities and data on development trends. (These projections were prepared prior to the 1980 Census. The fact that the base-year figure is higher than the census estimate will not affect the facilities plan, since the plan is considered to be accurate by 1985. Therefore, the figures have not been adjusted. The projected population distribution indicates that most people will locate in or near the urban area which will be served by sewers (see table 6-16). By the year 2000, the sewered population will be 100,800.

Land use projections. The land use component of the COMPLAN (figure 6-10) provides for orderly, balanced growth. The downtown/university area is projected to have slightly higher residential densities and more office development than in the rest of the area. Industrial uses are clustered by the airport and along major transportation routes. Otherwise commercial, public, semi-public, low and high-density residential and open space uses are distributed evenly throughout the urban area, primarily in neighborhood community units. In the rural areas some low-density residential growth (2, 5, and 10 acres/unit) is projected, particularly adjacent to the urban area on the east and in the vicinity of existing scattered development between the urban center and Lake Thunderbird.

By the year 2000, approximately 50 square miles will be developed, 30 square miles of which will be in the Little River watershed. For comparison, 1978 figures were 31 and 17 square miles, respectively. Table 6-17 presents total acreage by basin and the amount of land projected to be developed by the year 2000. In the rural areas, the land in the Little River watershed is projected to develop at densities of 0.6 to 1.4 people per acre or roughly 1 unit/2-5 acres. In the urbanizing portion of the basin, land will develop at

TABLE 6-16. PROJECTED POPULATION BY DEVELOPMENT TIER

Tier	Projected Population 1990	Projected Population 2000
Tier I	57,537	57,937
Tier II	34,292	36,572
Tier III	4,651	6,291
Subtotal (sewered)	96,480	100,800
Tier IV (partially or fully sewered basins)	10,720	11,200
TOTAL	107,200	112,000

Source: PSC, 1981.

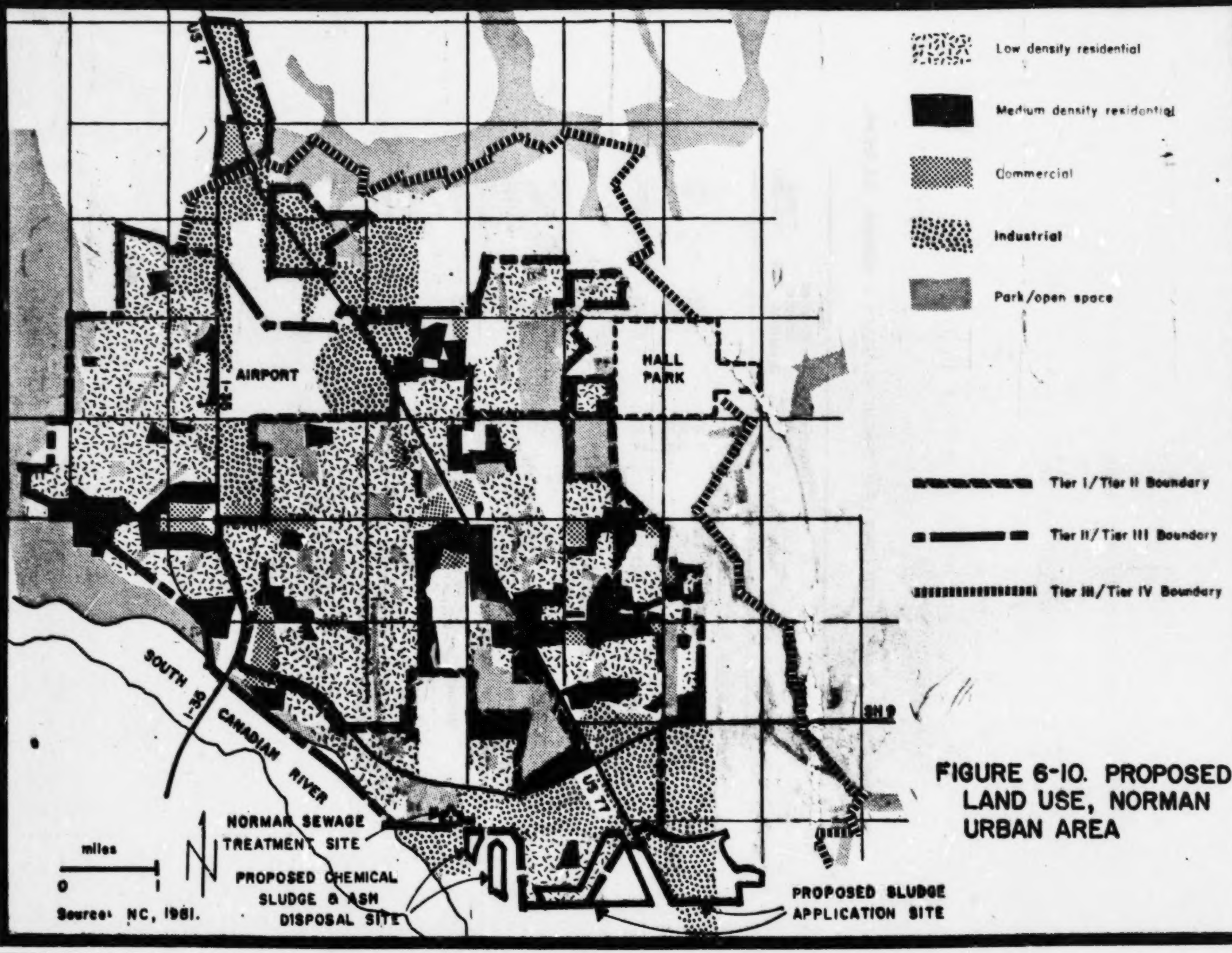

Low density residential
Medium density residential
Commercial
Industrial
Park/open space
Tier I/Tier II Boundary
Tier II/Tier III Boundary
Tier III/Tier IV Boundary
US 77
AIRPORT
I-35
HALL PARK
SH 9
US 77
SOUTH CANADIAN RIVER
I-35
NORMAN SEWAGE TREATMENT SITE
PROPOSED CHEMICAL SLUDGE & ASH DISPOSAL SITE
PROPOSED SLUDGE APPLICATION SITE
N
miles
0
1

FIGURE 6-10. PROPOSED LAND USE, NORMAN URBAN AREA

Source: NC, 1981.

TABLE 6-17. PROJECTED LAND DEVELOPMENT BY BASIN - NORMAN, OKLAHOMA.

Basin	Total Acres	Acreage Developed 1978	Estimated Acreage Developed, 2000	Change 1978-2000
S. Canadian R. Watershed				
A	13,350	2,200	5,170	2,970
B	4,200	3,580	3,650	70
C	7,880	3,170	4,000	830
Subtotal	25,430	8,950	12,820	3,870
Little River Watershed				
D	18,420	2,720	4,800	2,080
E	6,750	1,180	2,900	1,720
F	2,490	290	600	310
G	13,010	1,470	3,090	1,620
H	42,410	5,040	7,830	2,790
I	190	0	0	0
Subtotal	83,270	10,700	19,220	8,520
TOTAL	108,700	19,650	32,040	12,390

Source: PSC, 1981.

densities of about 8-10 people/acre or roughly 4 units/acre. The densities in the Canadian River watershed are somewhat higher, ranging from 8 to 12 people/acre in the urbanized area, but with similar, lower densities in Tier IV to the west.

Vacant land to the south of town, adjacent to the treatment plant and proposed disposal sites, is planned for industrial and residential development.

Development in the Little River basin. As figure 3-2 shows, the service area encompasses only a small portion of the Little River basin. The watershed above Lake Thunderbird also includes large areas of rural Norman, and acreage within the cities of Moore, Oklahoma City and Midwest City and the smaller towns of Slaughterville, Hall Park and Noble. The lake itself is within Little River State Park in Norman. The remaining few, small areas are subject to the direct jurisdiction of Cleveland County.

Table 6-18 summarizes land use patterns in the basin according to ACOG (1977a). The urban 10 percent of the basin is concentrated near the western drainage divide (figure 5-1). ACOG projected that within this area about 8,100 acres would convert from open space or agricultural uses to urban type uses by the year 2000. Of this, about two-thirds of the land undergoing development is in Moore, and about one-third is in Norman. In the "rural" 90 percent of the basin, ACOG projected residential and other urban development on about 3,800 acres, bringing the total conversion to nearly 12,000 acres over 25 years.

It appears from table 6-17 that growth patterns in the Little River basin portion of Norman will differ from those ACOG anticipated. In particular, about 7500 acres of land are projected to develop in low-density, residential estates in the rural areas of Norman alone. Projections for the urbanizing tiers in the basin are less than ACOG projections; about 1,100 acres are expected to be converted to residential uses. In addition to the residential land, some industrial land north of town (about 100 acres) could develop by the end of the study period. In total, 1,200 acres of the Little River basin in Norman would become urban by the year 2000, compared to over 2,000 acres projected by ACOG. Development in Moore and elsewhere in the basin appears to be proceeding more in line with the ACOG forecast.

In the context of these estimates, the urbanization which would be served by the proposed sewers is a small part of the development activity which is occurring in the Little River basin. The 1200 acres which are projected to develop would represent 10 percent of the urbanizing lands in the basin. Consequently, with or without any growth in the Norman portion of the watershed, a large increase in the acreage of urban lands in the basins is projected.

Environmentally significant agricultural lands. Agricultural lands are a diminishing resource and are considered a sensitive land use which should be considered for protection. Such lands are shown on figure 6-11, based on an 'Important Farmland Inventory' performed by the Soil Conservation Service for

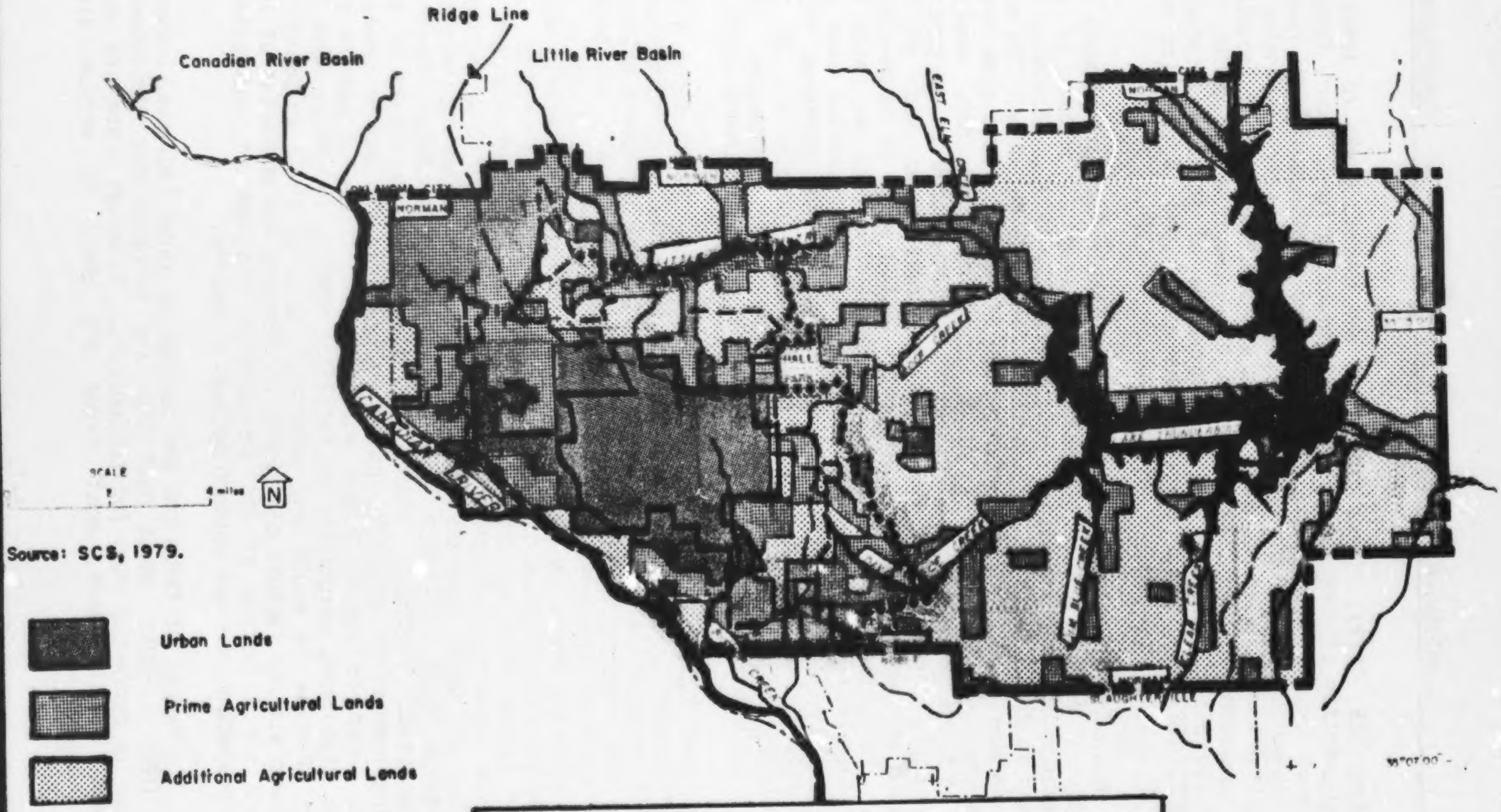
TABLE 6-18. LAND USE IN LITTLE RIVER BASIN - 1977 and 2000.

Includes Norman, Moore and all other portions of watershed.

	1977			2000		
	Urbanizing Basins	Other Areas	Total	Urbanizing Basins	Other Areas	Total
Industrial	246	2,487	2,733	867	2,488	3,355
Commercial	242	30	272	503	127	630
High-density residential a/	117	15	132	278	15	293
Low-density residential	2,265	1,497	3,762	8,379	3,787	12,166
Public/semi-public	656	64	720	736	64	800
Open space	3,230	61,859	65,089	2,928	61,788	64,716
General agriculture	10,928	0	10,928	3,993	0	3,993
Cropland b/	--	8,054	8,054	--	7,032	7,032
Pasture b/	--	28,524	28,524	--	27,837	27,837
Rangeland b/	--	26,173	26,173	--	19,889	19,889
Water	258	7,049	7,307	258	9,499	9,757
Other c/	--	6,105	6,105	--	9,332	9,332
TOTAL d/	17,942	141,857	159,799	17,942	141,858	159,800

a. More than 6 dwelling-units per acre.
b. Not irrigated. For urban area, all agriculture is lumped into the general category.
c. Mining; vacant; highways. Not calculated for urban areas.
d. ACOG acreage numbers were reduced 11% to give a basin total of approximately 256 square miles.

Source: Simplified from ACOG, 1977a: Tables 102-113, 102-114, 102-120, and 102-121.


Canadian River Basin
Ridge Line
Little River Basin
EAST ELM CREEK
OKLAHOMA CITY
NORMAN
CANADIAN RIVER
SCALE
0
4 miles
N

Source: SCS, 1979.

Urban Lands
Prime Agricultural Lands
Additional Agricultural Lands
Tier I/Tier II Boundary
Tier II/Tier III Boundary
Tier III/Tier IV Boundary

FIGURE 6-11.

PRIME AGRICULTURAL LANDS AND ADDITIONAL AGRICULTURAL LAND OF LOCAL AND STATEWIDE IMPORTANCE

Cleveland County (SCS, 1979). The objective of the inventory was to identify the extent and location of land best capable of producing food, fiber, forage, feed and oilseed crops. Such land can be farmed continuously or nearly continuously without degrading the environment, and it is very responsive to management for maintaining productivity. There are 318,980 acres of important farmlands in Cleveland County; 119,850 acres are classified as prime, the remaining 199,150 acres as other important farmlands of local or statewide importance (SCS, 1979). A small share of the prime land is used for crop production.

There are approximately 89,000 acres of land suitable for agricultural use within the city of Norman. This represents more than 25 percent of all important farmlands in Cleveland County (PSC, 1981; SCS, 1979). Virtually all undeveloped land in the city is in the important farmlands category. The most productive farms are located on the western edge of Norman. This area has a significant share of the county's prime croplands. Another, smaller concentration of prime lands occurs southeast of the urban area in the prairie soils natural unit. The city COMPLAN aims to preserve as much of the agricultural land as feasible. It has designated 17,000 acres to be developed in urban uses. The remaining 72,000 undeveloped acres have been set aside for rural and agricultural use in Tier IV. Although rural residential uses are permitted in Tier IV, the COMPLAN proposes to identify and preserve prime agricultural lands and to encourage clustering of new development in the vicinity of existing homes, in order to reduce impacts on farmlands. (See page 6-62 for a discussion of measures adopted to protect agricultural lands).

Through the year 2000, projected growth patterns will absorb about 4,500 acres in the urbanizing tiers and another 8,000 acres in the rural area; rural development will be principally to the east of town. The COMPLAN's policies should reduce the impacts of sprawl on agricultural lands. Scattered, low-density development fragments farmland causing agricultural land to be separated from adjacent tracts by subdivisions, thereby creating parcels which are less economical and efficient to farm using modern commercial methods. In addition, urban sprawl into agricultural land causes life-style changes, as the predominantly rural/agricultural landscape is converted into a suburban one. The fields and green expanses originally sought by urban dwellers are divided into large house lots with lawns and vegetable gardens. Traffic, dust, and noise levels increase. With these changes in the nature of the land, increasing numbers of wildlife, particularly birds and small mammals, leave the area. Farmers can no longer work in their fields at six in the morning without disturbing neighbors; to fertilize fields, neighbors must be notified ahead of time to avoid any potential harm to their property or health. These and similar factors contribute to changing the character of the rural areas and the lifestyle of its inhabitants, and are to some extent avoided if the projected land use pattern becomes a reality.

Countywide, the number of farms and the acreage in farms increased between 1974 and 1978 (USDC, 1980). About half the land suitable for "important" agricultural use is currently used for agriculture. Although there are very large operations in the area, most farms are small to medium size enterprises. Approximately 90 percent of the farms countywide have sales of under $20,000 (USDC, 1980). Three-fourths of the land in farms is used for pasture and one-fourth for crops. The major crops are hay (including alfalfa), which accounts for over 60 percent of the planted acreage, and wheat which accounts for another 20 percent. Other important crops are sorghum, soybeans and corn.

Cleveland County comprises a small share of Oklahoma's agriculture. Less than one percent of the state's farmlands are in Cleveland County. Likewise the production of the county's major crops also account for less than one percent of the state total. While Cleveland County is in the top 20-30 Oklahoma counties in the number of milk cows and farm chickens, these animals account for 1.6 percent and 2.7 percent, respectively, of the state total (ODA, 1979). Cleveland County is a local supply source for Oklahoma City, which is located on its border.

6.6.3 Impacts of the No Action Alternative

The No Action alternative would avoid any socio-economic and land use change resulting directly from the proposed action, but could encourage widespread, low-density growth on agricultural lands and in the Little River drainage. In particular, the adverse effects of sprawl on agricultural lands, described in section 6.6.2, would result from this alternative. If the municipal wastewater system cannot serve new development, then more growth would probably occur outside the urban area using independent wastewater plants or on-site systems. If all this development occurred at the low densities projected for the rural areas, the amount of agricultural lands converted to development under the No Action alternative could exceed 27,000 acres by the year 2000. Impacts on Lake Thunderbird would also increase if this growth concentrated in the Little River drainage where most undeveloped land is located.

6.6.4 Impacts of the Collection Alternative

Major impacts on the socio-economic environment and land uses are those resulting from growth. The proposed wastewater collection system alternative supports a compact urban form, which generally minimizes the adverse effects of growth. The major environmental issues associated with the proposed action are the impacts of urbanization on agricultural land and the potential for pollution of the Little River basin drainage. Other areas of potential impact include: provision of infrastructure; land use changes; disruption and safety hazards during construction; and changes in the socio-economic environment.

Impacts on environmentally sensitive agricultural land. Impacts of the collection system on agricultural lands are discussed in section 5.2. A total of 4,500 acres in the urban area are projected to develop during the study period; 1,500 acres would be served by the proposed collection system improvements. Of this, nearly 900 acres would be served by interceptors in the existing service area and 600 acres by construction of interceptors to the expanded service area. Most, if not all, of this land is well suited for agricultural use. It represents 0.4 percent of the agricultural lands in the county. Although this land would not be available for future agricultural use, the sewered growth pattern minimizes the impact of development on farmlands because it is relatively compact, with most development occurring as infill to already urbanizing sectors.

Impacts of growth on the Little River basin. The proposed action would facilitate the conversion of nearly 1,500 undeveloped acres to urban use. Two-thirds of this land is in the Little River basin. Since runoff from urbanized lands carries more pollutants than runoff from open, undeveloped lands, this development would have an adverse effect on the water quality of area streams. In addition, the streams in the Little River basin feed Lake Thunderbird. Thus, there is the potential that Lake Thunderbird's water quality would also be degraded. The extent and nature of these impacts are discussed in sections 5.2. and 6.2.6.

From the collection system expansion itself, effects on Lake Thunderbird are projected to be small. However, considering growth throughout the watershed, there is the potential for adverse water-quality changes in the future. This could reduce the lake's value as a water supply and recreational resource. Costs for purification could increase or, in the extreme, more use of ground water would be required. Impairment of the lake's recreational value could be severe because it is the only major, water-based recreational area serving the Oklahoma City region.

Other land use impacts. There would be 77,641 feet of interceptor lines installed requiring an average 40-foot wide easement along the length of the route. Although all interceptor routes have not been finalized, they are to be routed through existing and proposed rights-of-way to the extent possible. The rights-of-way are generally routed through open space areas or along streets adjacent to individual properties. Thus, long term impacts on existing land uses should be minimal. Also, as a result of the proposed action, the 20-acre site now occupied by the Woodcrest emergency pond would become available for other uses and many of the interceptor rights-of-way could be developed in bike or walking trails, particularly along creek beds.

Impacts on infrastructure. Planning for the extension of infrastructure into developing areas has been coordinated with the COMPLAN; therefore, the growth pattern supported by the proposed action should have no adverse effects on infrastructure.

Construction impacts. Construction impacts, are discussed in chapter 5 (see tables 5-2 and 5-3). Sewer construction generally restricts traffic flow when lines are placed in street rights-of-way. Street closings commonly occur, especially during the excavation period. Impacts resulting from traffic disruption include: inconvenience to those who use the affected street, especially if the street is used to provide access to homes or businesses; a temporary decline of business at commercial establishments; and increased noise and vehicle emissions on nearby streets which receive rerouted traffic.

When excavated trenches cross underground utilities, such as gas and water lines, it may be necessary to interrupt service for a brief period, or to relocate the other utilities. To minimize the effect of utility disruption, contracts are normally required to determine all utility locations along the sewer right-of-way, and to take steps to ensure coordination of activity at the construction site. Only utility owners are permitted to undertake relocations. Impacts of construction in a flood plain are discussed in section 6.2.5.

Socio-economic impacts. Social and economic impacts induced or facilitated by the proposed action include the following.

- Potential health hazards from overflows into streets and parks would be eliminated.
- The enjoyment of outdoor activities in Bishop Creek, downtown and in the southeast along Highway 9 would be enhanced by the elimination of current odor sources associated with the interceptors, inadequate septic systems, and the emergency holding pond.
- Rehabilitation of older homes and revitalization of older areas would be facilitated, stabilizing lower-income neighborhoods and preserving low income housing stock.
- In the Bishop Creek service area, the moratorium has virtually halted land sales with the resulting impact of depressing land values in the area. Once the moratorium is lifted, appraisers expect the worth of vacant land to increase 2 to 4 times its current value depending on the type of land and its location (Wells, 1980). Generally, the increased values will be equivalent to similar properties outside the moratorium area.
- As development occurs and reappraisals are done of vacant land in the Bishop Creek area, the assessed valuation will increase and contribute to expansion of the city's tax base.
- Residents would experience increased costs to pay for sewer improvements. This impact is discussed in sections 5.5.8 and 6.6.7.

Other impacts. Generally, implementation of the proposed action would permit the Norman area to develop in accordance with the COMPLAN. Infill of vacant lots and rehabilitation of existing structures would be able to proceed in the downtown area, strengthening the city's efforts at revitalizing older areas of town. Except for some institutional property, development of major vacant tracts in Tier I would occur as desired by the city. In Tier II, development would occur as projected in neighborhood units, providing for a mixture of low and medium density residential uses as well as neighborhood parks and small commercial areas. While not all land is projected to be developed in this area by 2000, the progression would be able to occur in an orderly compact form. Some initial growth would also occur in Tier III. Further, resumed growth in the Bishop Creek area would permit a balanced distribution of population growth around the downtown area.

There are two aspects of the facilities plan which could conflict with the COMPLAN by encouraging growth to occur sooner than desired in portions of Tier III and the Bishop Creek area. One is the proposed location of lift station D in an area where little growth is projected. The other is the capacity of lines C-1, C-10, and C-11 which pass through the Bishop Creek service area to carry flows from interceptor E. The impacts of these actions are discussed in section 5.2.2. Another potential impact is presented by capacity of the lines. In conformance with city policy, they are designed to carry year 2000 flows with no excess capacity. If growth occurs faster than projected, problems of overloaded lines could result. This potential impact is also discussed in section 5.2.2.

An issue raised by the Citizens Advisory Committee is the timing of interceptor construction to basins E and G and the impact this could have on growth patterns. The facilities plan recommends construction of these lines later in the study period, as growth warrants. Planning for these interceptors now enables city planners to maintain access to necessary route alignments and provides a guide for designing other systems which would connect with these interceptors in the future.

Interceptors E and G are designed to serve future growth in Tier III after adjacent land in Tier II builds out. In conformance with the COMPLAN, city policies effectively encourage this pattern, but do allow construction in Tier III if a developer is willing to pay for extension of the interceptor. If future interceptors are built earlier in the planning period than the orderly extension of growth warrants, the presence of the line is likely to attract other developers, thus contributing to a less compact urban form, a more costly growth pattern, and gaps in the overall infrastructure system. Any time a proposal would result in the early construction of an interceptor, the impacts of the action will need to be considered. In some cases the impacts could be minor; in others, mitigation measures could be used by the city to minimize the impacts.

Summary of impacts. The impact of 37,940 new residents over a 20-year period could be significant. The growth patterns supported by the collection alternatives are in conformance with the COMPLAN, which generally minimizes the adverse effects of growth. Most adverse impacts are short-term and not severe. However, urban growth will result in the loss of some agricultural lands and will contribute to potential changes in the water quality of Lake Thunderbird. Such impacts would be even greater if growth patterns do not conform to the COMPLAN.

6.6.5 Impacts of Treatment Alternatives

Additional land requirements for each treatment alternative are outlined in table 6-19. With the exception of the land application alternative, all land which would be required is undeveloped, owned by the city, and adjacent to the existing site (see figure 6-7). There would be no adverse impacts on land use if these parcels were added to the treatment plant site.

The only land application alternative evaluated in the facilities plan would require acquisition of 3,930 acres of farmland. The most feasible site is located southwest of the treatment plant in Goldsby. Several families would have to be relocated if this alternative is chosen. It would also require relocation of the Goldsby Landing Field and and the Goldsby Church. It is unlikely that this land application alternative will be selected. If it is, it would have potentially severe adverse impacts on land use patterns in Goldsby. However, other land application alternatives with less adverse impacts may exist.

6.6.6 Impacts of Sludge Management Alternatives

Land requirements for each of the alternatives are set forth in table 6-19. The proposed disposal sites are located southeast of the treatment plant (see figure 5-4). The land is currently undeveloped, although it is suitable for agricultural use. The sludge disposal alternative would enhance the long-term productivity of the land because of the organic matter and nutrients contained in the applied sludge. However, due to the possible buildup of toxic metals it would not be suitable for production of food-chain crops. Once the site is closed it would be available for limited agricultural or other uses. The chemical and ash disposal site could not be used in the future for agriculture but could be developed for recreational or industrial use.

The disposal sites are adjacent to a proposed residential area and a half-mile from an existing residential area. Adverse health effects could result from handling of wastes in the sludge disposal area. This is a potential hazard, particularly to children who could wander over from the neighborhood areas. This potential would be minimized, since the sludge would be incorporated into the soil and the site would be fenced. If alternative 1 or 2 is selected, the site could also, at times, generate odors which could adversely effect outdoor activities in the residential areas. Minor odor problems could also be perceived by workers in the adjacent industrial areas or travelers on Highway 77 which bisects the sludge disposal site.

6.6.7 Impacts of Other Types of Alternatives

The alternative of a more aggressive approach to management of on-site systems (section 5.5.1) would add to administrative burdens on local governments. Alternatives to accomplish odor control at the plant (section

TABLE 6-19. LAND REQUIREMENTS FOR ALL ALTERNATIVES.

Land requirements are in addition to land utilized by the current treatment plant. For levels B and C, no land would be requirec in addition to that needed for level A.

Wastewater Treatment Alternatives	ACRES
Level A treatment	
Alternative 1 (jet activated sludge)	10
Alternative 2 (biofilter/jet activated sludge)	10
Alternative 3 (biofilter/conventional activated sludge)	0
Alternative 4 (biofilter/bio-discs)	0
Level D treatment	
Alternative 5 (biological nitrification)	10
Alternative 6 (breakpoint chlorination)	10
Alternative 7 (land application)	3,930
Sludge Management Alternatives	
Level A treatment	
Alternative 1 (lime conditioned sludge, land application)	275
Alternative 2 (anaerobic digestion, land application)	205
Alternative 3 (co-disposal)	20
Alternative 4 (incineration of sludge)	4
Level D treatment [a]	
Alternative 1 (lime conditioned sludge, land application)	747
Alternative 2 (anaerobic digestion, land application)	572
Alternative 3 (co-disposal)	80
Alternative 4 (incineration of sludge)	64

[a] Includes 60 acres for disposal of chemical sludge.

Source: PSC, 1981.

5.5.4) would enhance the enjoyment of outdoor activities in residential and public areas north and east of the plant. Study of pollutant sources (section 5.5.6) would provide information and guidance for future land use planning for the Little River basin. Administration alternatives (section 5.5.7) would require ordinance modification and enforcement.

Decisions made with respect to project funding (section 5.5.8) will determine who pays for the proposed improvements. Average sewer charges could increase by as much as $140 per connection per year, which would substantially increase the utility costs for most residents. This increase can be reduced to the extent that EPA funding is obtained or the local share is obtained from methods other than sewer rates as described in chapter 5. All money collected would return to the local, regional or national economy in the form of construction jobs, operational jobs, and the purchase of materials and energy.

6.6.8 Impacts of EPA Alternatives

Major long-term impacts on land use and the socio-economic environment result from the area's growth. Its major adverse impacts are: loss of agricultural lands and potential changes in the water quality of Lake Thunderbird. The degree of impact is reduced by the compact urban form provided for in the COMPLAN and facilitated by the proposed action. If COMPLAN is followed, growth impacts in Norman are likely to be much the same whether or not EPA provides funding. However, EPA funding of these actions would be consistent with policy, which is to minimize impacts on environmentally significant agricultural lands and other natural resources.

Short-term construction impacts (such as disruption of traffic and utilities) are an inevitable result of taking steps to correct existing pollution problems and provide for orderly growth. EPA alternatives would not alter these impacts, except that the normal funding process provides an added level of review which helps ensure that mitigation measures such as listed in table 5-3 are considered for inclusion in construction contracts.

The main economic impact of the alternatives stems from the high total cost of the proposed facilities; these costs would be increased by selection of alternatives other than those proposed by the Applicant. EPA funding, if any, would reduce the local share of these costs and result in lower sewer rates.

6.7 ENERGY AND OTHER RESOURCES

The major resources associated with all the alternatives are energy and chemicals. Materials such as concrete and steel would be used for construction of new facilities. Note that use of materials also implies use of energy; for example, a large amount of energy is expended in order to produce chlorine gas. In general, cost is a surrogate for energy use, since the energy used for production and transportation of materials and for construction and operation of facilities is a major portion of the cost.

6.7.1 Existing Conditions

The Norman wastewater treatment facility currently uses 3.61 million kilowatt-hours (kwh) of electricity per year. Another 0.1 to 0.2 million kwh/year of energy are consumed by lift stations. In a year, the treatment facility also requires 55-60 tons of chlorine for disinfection, 10-15 tons of lime for pH stabilization and 2 barrels of enzymes for the breakdown of grease accumulations. The fuel use of facility vehicles is estimated at 6,000 gallons per year.

6.7.2 Impacts of the No Action Alternative

Implementation of the No Action alternative would conserve the energy and materials which otherwise would be used for construction and operation of new collection lines and treatment facilities. However, other impacts of the No Action alternative (section 5.1) would result in increased energy and material consumption. For example, the poorer the effluent quality, the greater the amount of chlorine required for proper disinfection. Less compact growth patterns, the result of relying on on-site systems, would result in greater consumption of energy for transportation, provision of police services, etc.

6.7.3 Impacts of the Collection Alternatives

Energy requirements for operation of the proposed new lift stations would be as follows:

LS-D	163,374 kwh/yr
LS-E	17,427 kwh/yr
LS-G	60,993 kwh/yr

As wastewater flows increase, energy use of existing lift stations would also increase. Overall, the proposed collection system would more than double electricity use over existing usage.

Improvements to the sewage system would require the following amount of pipe.

pipe size	feet
10"	7,510
12"	1,725
15"	2,800
16"	12,000

pipe size	feet
18"	14,000
21"	7,900
24"	3,420
30"	17,700
33"	10,586
Total	77,641

These quantities do not include lines for future construction. Pipe units 16 inches in diameter and under would be constructed from either PVC, vitrified clay or ductile iron. Pipe units 18 inches in diameter and over would be constructed from concrete.

6.7.4 Impacts of Treatment Alternatives

Energy and treatment costs are directly related. The greater the amount of treatment provided, the greater the use of energy. The greater the use of energy, the greater the cost. Table 6-20 compares construction costs, operation and maintenance costs, and usage of energy and chemicals.

The bio-filter/bio-disc alternative for level A would have the lowest operating energy requirement (2.95 million kwh/yr); next lowest would be the bio-filter/conventional activated sludge alternative (4.56 million kwh/yr). The other two alternatives for level A, the activated sludge and the bio-filter activated sludge system, both would have requirements of 5.81 million kwh/yr. Of the level D alternatives, land application would have the lowest operating energy requirement (5.69 million kwh/yr). Biological nitrification would use somewhat more energy for operation (6.31 million kwh/yr). Breakpoint chlorination would require more than twice as much energy as the other level D alternatives (17.4 million kwh/yr).

In terms of overall operation and maintenance costs, the most efficient alternative would be level A, alternative 4 ($464,514 annually). Other level A alternatives are considerably more expensive to operate.

Chemical use would vary between the treatment alternatives. Chlorine used for all the alternatives would be 122 tons/year with the exception of alternative 6 (breakpoint chlorination) which would require 273.7 tons/year. Alternative 6 would also use 456.6 tons/year of caustic and 106.6 tons/year of sulfur dioxide. Alternative 5 (biological nitrification) would also require 3,044 tons/year of lime at level D treatment.

6.7.5 Impacts of Sludge Management Alternatives

Table 6-21 provides information on energy requirements of the sludge treatment and disposal alternatives. Although energy requirements are not

TABLE 6-20. ENERGY AND CHEMICAL USAGE OF THE SEVEN TREATMENT ALTERNATIVES.

All costs in 1980 dollars.

Treatment Alternative	Construction (Capital Costs)	Materials for Repair (Annual Costs)	Energy (Million kwh/yr)	Power Requirements (Annual Costs)	Chlorine (tons/yr)	Operation & Maintenance (Annual Costs)
Level A						
1. Activated sludge (Jet system)	$ 6,083,000	$ 40,000	5.81	$ 232,383	122	$ 605,764
2. Bio-filter and activated sludge (Jet system)	6,198,000	46,000	5.81	235,176	122	611,764
3. Bio-filter and activated sludge (Conventional)	5,376,000	43,000	4.56	186,278	122	575,020
4. Bio-filters and bio-discs	5,747,000	42,000	2.95	122,234	122	464,514
Level D						
5. Biological nitrification a/	14,844,000	110,500	6.31	222,134	122	1,123,914
6. Breakpoint chlorination b/	14,844,000	98,450	17.4	146,334	2,739.7	1,830,363
7. Land application c/	27,090,000	not available	5.69	not available	122	1,022,300

a. lime requirements: 1,141 tons/yr for Level C; 3,044 tons/yr for Level D.
b. caustic requirements: 456.6 tons/yr.
c. sulfur dioxide requirements: 106.6 tons/yr.

Source: PSC, 1981.

TABLE 6-21. NET ENERGY REQUIREMENTS FOR THE SLUDGE MANAGEMENT ALTERNATIVES.

Figures were not available for alternative 2. KWH/yr = kilowatt hours per year. BTU/yr = British thermal units per year.

	Alternative 1 Land Application/ No Energy Recovery		Alternative 3a Codisposal/Cogeneration of Steam & Electricity		Alternative 3b Codisposal/Electricity Production Only		Alternative 4 Sludge Incineration No Energy Recovery	
	Electricity KWH/yr	Fuel Million BTU/yr	Electricity KWH/yr	Fuel Million BTU/yr	Electricity KWH/yr	Fuel Million BTU/yr	Electricity KWH/yr	Fuel Million BTU/yr
A. ENERGY CONSUMPTION								
Sludge Treatment	88,400	3,312	177,000	-	177,000	-	177,000	-
Sludge Transportation	-	494	-	-	-	-	-	-
Sludge Disposal	-	379	-	17,220	-	17,220	403,000	25,270
Ash Disposal	-	0	-	760	-	760	-	220
TOTAL	88,400	4,185	177,000	17,980	177,000	17,980	580,000	25,490
TOTAL ENERGY CONSUMPTION [a] (equivalent million BTU/yr)		4,487		18,580		18,580		27,460
B. ENERGY PRODUCTION								
Power	-	-	7,884,000	-	14,454,000	-	-	-
Steam	-	-	-	45,380 [b]	-	-	-	-
Total	0	0	7,894,000	45,380	14,454,000	0	0	0
TOTAL ENERGY PRODUCTION [a] (equivalent million BTU/yr)		0		72,280		49,320		0
C. NET ENERGY REQUIREMENT		4,487		- 53,700 [c]		- 30,740 [c]		27,460

a. Total energy (fuel and electricity) in million BTU/yr, using conversion factor of 3,412 BTU/KWH.
b. Work produced, in equivalent million BTU/yr, not accounting for heating or other thermal conditioning processes.
c. Net energy produced (i.e., total energy production is greater than total energy consumption).

Source: PSC, 1981.

available for alternative 2 (land application after anaerobic digestion), cost analyses are. The total present worth values of treatment level A which include treatment, transportation and disposal of the sludge are $4,073,380 for alternative 1 (land application of lime-conditioned, dewatered secondary sludge) and $4,439,783 for alternative 2 (land application of digested sludge) (PSC, 1982). The higher cost of alternative 2 indicates that it would also use more energy than alternative 1. Heating of digesters for alternative 2 would require twice as much energy as for alternative 1, but no power for operation of vacuum coil filters would be required for alternative 2. Of the four sludge treatment and disposal alternatives, alternative 1 would consume the least amount of energy while alternative 4 (sludge incineration) would consume the greatest amount. Alternative 1 would consume 4,487 million BTU/year; alternative 3 (codisposal) would consume 18,580 million BTU/year and alternative 4 would consume 27,460 million BTU/year.

In terms of net energy requirements, alternative 3a (codisposal/cogeneration) with production of both steam and electricity would be the most energy efficient. The energy produced by this alternative would be 53,700 million BTU/year greater than the energy consumed. The energy that would be produced by alternative 3b (codisposal with production of electricity only) would offset energy consumed by 30,740 million BTU/year. Both the land application and the sludge-only incineration alternatives would produce no electrical energy, although land application to agricultural soils would contribute to crop growth and reduce energy used to produce a commensurate amount of chemical fertilizer. Without considering fertilizer value, the net energy consumption for the land application and incineration alternatives would be 4,497 and 27,460 million BTU/year respectively (PSC, 1981).

For treatment level A, sludge disposal from alternatives 1 and 2 (land application) would require greater amounts of land than the other options. Alternative 1 (lime conditioned sludge) would require 275 acres for sludge disposal, while alternative 2 (anaerobically digested sludge) would require 205 acres. This lower land requirement is offset by the cost increase that would be due to transportation of all the sludge in liquid form (PSC, 1982). At treatment level D, a maximum of 687 acres would be required for sludge disposal. Alternatives 3 and 4 (codisposal and incineration) would each require only 1 acre per year for ash disposal, 20 acres over the planning period.

Chemical usage would vary between the alternatives as well. Alternatives 3 (codisposal) and 4 (incineration) would each require 36 tons of ferric chloride per year. Alternative 1 (land application of lime conditioned sludge) would require 286 tons of lime per year. Alternative 2 (land application of anaerobically digested sludge) would require no chemicals.

6.7.6 Impacts of Other Alternatives

All alternatives discussed in section 5.5 would involve some energy and resource use. For example, one of the most common method for upgrading of on-site systems (section 5.5.1) is to use aerobic tanks which require electricity for operation. Disinfection (section 5.5.2) uses chemicals which require considerable energy for production. Energy conservation measures (section 5.5.3) have obvious benefits in saving resources; an example is the recycling of methane gas produced during sludge digestion.

Water conservation (section 5.5.5) would reduce energy for water pumping, and energy and chemicals for water treatment, as well as reducing energy and chemical use for wastewater treatment. Control of nonpoint sources (section 5.5.6) would require energy and construction materials for structural measures such as detention ponds.

6.7.7 Impacts of EPA Alternatives

EPA's funding options could have a significant impact on resources if the agency determines that one of the more resource intensive options is cost-effective. For example, EPA might chose to grant funds only if level D treatment were developed. While level D treatment would enhance the quality of the Canadian River, it would require substantial expenditure of capital, energy and chemicals.

6.8 SUMMARY OF ADVERSE IMPACTS, ENVIRONMENTAL TRADEOFFS AND RESOURCE COMMITMENTS

Table 6-22 summarizes the impacts of the alternative most likely to be the Applicant's preferred alternative (as discussed in section 5.6). Of major concern to EPA policies (table 3-1) are impacts on sensitive resources, such as wetlands; flood plains; environmentally significant agricultural lands; aquifer recharge zones; historic and archaeological resources; and recreational and open space areas. Impacts on these resources are discussed as follows: wetlands, or riparian habitat (see section 6.4); flood plains (see section 6.2); archaeological and historic resources (see section 6.5); important farmlands (see section 6.6); aquifer recharge zones (see section 6.2); open space areas (see sections 6.3 and 6.6).

6.8.1 Adverse Impacts Which Cannot be Avoided

Construction of new wastewater facilities would have adverse short-term impacts (see table 5-2). These include: minor amounts of erosion, sedimentation, and siltation; vegetation disturbance; dust and equipment emissions; noise; traffic disruption; and construction hazards. While these effects can be mitigated (table 5-3), they cannot be avoided if Norman is to comply with its NPDES permit and provide for orderly growth.

Development of the area would result in urbanization of up to 13,000 acres of environmentally significant agricultural land, of which 1,500 acres would be directly served by the proposed sewer system. Even more conversion of

TABLE 6-22. SUMMARY OF IMPACTS OF THE APPLICANT'S PROBABLE PREFERRED ALTERNATIVE.*

Adverse impacts are generally those which cannot be avoided except by the No Action Alternative; most of the adverse impacts can be mitigated. In addition to impacts identified below, substantial short-term benefits are associated with construction jobs, expenditures.

*A preferred alternative has not been selected; this table is based on the most likely alternative: treatment - Alt. 4 biofilter/biodiscs; sludge management - Alt. 2 anaerobic digestion, land application; proposed collection system.

ENVIRONMENTAL RESOURCE	SHORT-TERM ADVERSE IMPACTS	LONG-TERM ADVERSE IMPACTS	LONG-TERM BENEFITS
EARTH RESOURCES	Accelerated water erosion resulting from construction of facilities, especially where sewer lines lie in or cross a waterway	Sludge injection site could experience increased erosion, metals buildup in soils	Improved soil properties at sludge injection site (possibly enabling ultimate recycling of soil)
WATER RESOURCES	Dewatering during construction could cause water-table lowering, odors, water-quality changes	New interceptors located in flood hazard zones; degraded water quality in ruoff; potential degradation of water quality of Lake Thunderbird and of ground water beneath sludge disposal site	Increased flows in Canadian due to greater wastewater discharge. Improved quality of the Canadian, due to enhanced quality of effluent
AIR QUALITY; ODOR; NOISE	Equipment exhausts, dust and noise during construction	Small increase in emissions, noise at treatment plant; potential odors from sludge land application site	Reduced odors at treatment plant and from collection system
BIOLOGY	Temporary loss of vegetation and habitat at some construction sites, especially waterways	Loss of grasslands habitats at disposal sites; possible removal of some trees along creek alignments; potential decrease of fish in Lake Thunderbird and wildlife which feed on fish	Improved aquatic habitat in the Canadian; productivity and habitat value of sludge injection site ultimately improved
ARCHAEOLOGICAL & HISTORICAL RESOURCES	None expected	Possible loss of archaeological resources at new facilities, although no impacts are likely	No impact
SOCIO-ECONOMICS AND LAND USE	Traffic and utility disruption along construction corridors; reduced access to businesses and homes	Loss of agricultural land to support growth; potential impact on water quality of Lake Thunderbird with attendant impact on its value as a water supply and recreational resource; substantial increases in sewer rates or property taxes	Collection system supports compact urban form which will minimize impacts on agricultural land while supporting planned infrastructure; elimination of potential health hazards from overflows; potential use of some interceptor alignments for trails; restoration of land values and construction activity in Bishop Creek area
ENERGY & OTHER RESOURCES	Utilization of energy and resources during construction	Wastewater treatment requires major commitments of funds, labor, energy, materials	Net reduction in per capita resource use for wastewater treatment; support of compact urban form which requires less energy use

farmland (27,000 acres) would occur if the projected development is not sewered. While harm is not certain, urbanization does increase the potential for adverse impacts on the water quality of Lake Thunderbird. The proposed action would contribute to this impact, although even greater effects would be possible through sprawling growth should adequate facilities not be provided.

Solution of the wastewater problems of the area requires substantial investment of public funds, which, at least partially, would be paid from higher sewer rates or property taxes. This investment of resources is a necessary step toward compliance with environmental standards, and cannot be avoided. EPA funding would reduce the economic burden on local residents.

6.8.2 Short-term Uses of the Environment versus Long-term Productivity

Short-term environmental uses are primarily limited to construction impacts (especially of the collection system). The beneficial impacts are long-term and relate especially to providing a healthful environment and basic infrastructure. Without timely action, overloading of sewer lines would continue to cause odor and potential health problems. Upgrading of the treatment facility would promote long-term productivity by improving the water quality and ecology of the Canadian River. In turn, this would enhance the use of the river for swimming, fishing, irrigation and other purposes. The proposed service area supports the protection of agricultural lands and thus benefits long-term agricultural production in the planning area. The proposed collection system also supports orderly development in the Little River basin with the long-term result of minimizing degradation of the Lake Thunderbird drinking water supply. The provision of a healthful water supply increases the health and thus the productivity of the population served.

6.8.3 Irreversible and Irretrievable Commitments of Resources

Major categories of resources to be utilized by the proposed treatment and capacity alternatives were identified in section 6.7 and include energy, construction materials, labor and capital. These (largely irretrievable) commitments are substantial, and are necessary if proper wastewater management is to be accomplished.

CHAPTER 7

COORDINATION

7. COORDINATION

7.1 PUBLIC PARTICIPATION PRIOR TO RELEASE OF THE DRAFT EIS

Scoping Meeting. The Norman EIS was begun in mid-1978, when requirements with respect to public participation and scoping were less formal. No general "scoping" meeting was held, bit a series of public citizens advisory committee meetings were held for the purpose of identifying significant issues to be addressed in the EIS (see discussion below).

Citizens Advisory Committee. In order to maximize public input during the EIS process, a Citizens Advisory Committee (CAC) was formed by the city in 1978. The CAC was appointed by the City Council, either by Ward or at-large, to represent a cross-section of local interests.

A list of committee members follows.

	appointment	
James H. Davis, Chairman	at-large	432 Thorton Drive
Bill J. Brown	at-large	210 North Flood
Henry M. Enterline	Ward four	P.O. Box 2842
C.H. Lawrence	at-large	2703 Willow Creek
Hazel McClure	at-large	3829 120th Avenue
John H. Patten	Ward six	P.O. Box 270
Lois A. Pfiester	Ward seven	1604 Sunrise
Richard Powell, Jr.	at-large	1618 Greenbriar
Walter Shaw	Ward one	1909 Oak Hollow
Leale Streebin	Ward three	2301 Morgan Drive
Gene Tyner	at-large	910 McCall
Stephen Whitmore	Ward eight	1220 Avondale

(three vacancies now exist on the committee)

The CAC has been involved in the EIS process on an ongoing basis, and has been the major vehicle for obtaining public input regarding wastewater management alternatives. The major issues considered by the CAC are identified in section 7.2. The following specific public participation activities were accomplished by the city and its committee.

1. Depositories for written information were established as follows:

   A. City Clerk's Office, Norman;
   B. Pioneer Multi-County Library, Norman.

All minutes and other documents identified in this chapter are available at these depositories.

2. Between May, 1978 and January, 1981, close to twenty meetings were held in connection with the planning process, at major decision points and at many intermediate points. Public comments and inputs were received throughout this period. Formal public meetings were announced on the City Clerk's bulletin board and covered in the local newspapers.

3. As discussed in section 4.2, an Environmental Information Document (EID) was previously prepared for the City of Norman regarding the Bishop Creek Interceptor project. The EID was distributed to the CAC for their review and comment. At the CAC meeting of September 10, 1980, the CAC recommended the relief sewer plan to the city, and further recommended that "prompt favorable consideration be given by EPA for appropriate funding support to the City of Norman".

   A public hearing on the Bishop Creek Relief Lines Project was held on September 18, 1980. The purpose of the hearing was to encourage public participation in the project's planning, review and decision making process. Discussion focused on the potential environmental impacts of, and alternatives to, the proposed project. Notice of the hearing was published twice in the "Legal Notices" section of The Norman Transcript, on August 1, 1980 and August 15, 1980.

4. Since the availability of a preliminary draft facilities plan on September 2, 1981, the CAC has held six meetings to discuss and identify the citizen concerns with the alternatives presented in the pre-draft plan.

   The preliminary draft EIS has also been presented to the CAC. Thus far, the largest issue of discussion is the selection of a sludge management alternative. Further CAC meetings will be held.

7.2 MAJOR ISSUES IDENTIFIED DURING PUBLIC PARTICIPATION PROCESS

Meetings of the CAC resulted in the development of three levels of pertinent issues, as listed below (Letter prepared by the CAC Chairman, October 24, 1978).

Priority ONE issues:

1. Protection of Lake Thunderbird as a drinking water supply. This includes the Little River above Lake Thunderbird, and ponds near Hall Park. It is recognized that the Hall Park wastewater system may become part of Norman's problem whether we desire it or not.

2. Protection of ground water in the Garber-Wellington Formation.

3. Protection of water in stream alluvium.
4. Management of growth and city services, including the industrial potential of the city.
5. Protection of the South Canadian River as a recreational outlet, a wildlife habitat, and a place where unusual flora are known to grow.
6. Condition of sewers and sewer service in the established areas of Norman, including state of repair, and adequacy of capacity.
7. Control of odors.
8. Concern for dangerous chemicals entering the water supply, including non-point sources.
9. Improvement of the Bishop Creek interceptor as a specific plan item in order to provide remedial wastewater facilities on the east side of Norman.
10. Location, type, and capacity of additional treatment plant facilities. This should take into account type of treatment, potentials for energy and cost savings, and associated potentials such as land application and other innovative or advanced methodology.
11. Erosion and sediment control, from the standpoint of the land itself, as well as the effect on Lake Thunderbird and any streams effected.
12. Sludge disposal and composting, taking into account where it may go for a protracted period of years, and its use for practical purposes, including possible sale of the sludge as a commercial product.
13. Inter-relationship of storm sewers and wastewater sewers, with the aim of minimizing mutual interference of the two.
14. Necessary new or modified ordinances to assure proper use of wastewater facilities, in particular ordinances concerning industrial use and recovery.
15. Assurance of compliance with EPA standards.

Priority TWO issues:

1. Relative costs of alternative systems, in terms of initial capital outlay, maintenance costs over future years, and tax costs of the future.
2. Effect of high-density versus low-density residential land use.
3. Effect of growth on air quality.

4. Loss of agricultural land.
5. Effects on sewer utility rates.
6. Land acquisition problems.
7. Use of lift stations.
8. Coordination of the plan, as necessary or advisable, with other communities which affect Norman, or which Norman affects.
9. Legal restraints on the initial installation of the system, its use, and in applying financial charges for its use.

Priority THREE issues:

1. Protection of Lake Eufaula.
2. Protection of the Little River below Lake Thunderbird.
3. Road and traffic problems during construction and future maintenance.
4. Employment opportunities for the construction phase and for operation of the expanded facilities.
5. Effects, if any, on aesthetics, and on archaeological or historical sites.

In addition to the above issues, additional concerns were identified by the Environmental Protection Agency in their Notice of Intent to prepare an EIS. These issues included the following.

A. Project alternatives - All feasible project alternatives, including the "no action" alternative, which are developed in the facility planning process will be evaluated to determine their environmental soundness. Special attention will be given to those alternatives which represent the most cost-effective actions.

B. Primary and secondary impacts - All primary and secondary impacts, both beneficial and adverse, that could result from proposed collection system or treatment plant construction, shall be evaluated. Primary consideration should be given to the following areas of concern:

1) Water quality,
2) Air quality,
3) Biological resources, and
4) Noise.

C. Socio-economic effect of construction and operation - Impacts of this project on the economic stability of the citizens, both directly and indirectly, shall be analysed.

D. Archaeological/historical resources - The city will follow the procedures of the Advisory Council on Historic Preservation and the Oklahoma Historical Society to insure the protection of archaeological, historical, and cultural resources.

7.3 ON-GOING COORDINATION

Table 3-1 summarizes the coordination requirements associated with EIS preparation. Appendix C contains replies to letters requesting coordination with the proposed action. It also contains a floodplains construction notice in compliance with Executive Order 11988.

Preparation of the EID on the Bishop Creek Interceptor involved extensive coordination, as described in that document (LWA, 1980). The EID was distributed to a mailing list which consisted of local, state and federal agencies, interest groups and individuals who were known to have an interest in the project. In addition, publication of the EID was publicized in the media and through public notices in the local newspaper (see next item). The publicity indicated a review copy of the EID was available at the public library.

Written responses to the the EID consisted of ten letters, none raising major issues about the environmental impact of the proposed action. A public hearing was held on September 18, 1980. Public notices announcing the hearing and announcing the publication of the EID were published in the Norman Transcript on August 1 and August 15, 1980. Notification concerning the effects of the proposed action on floodplains was made (see Attachment Three to the EID). Two citizens testified in support of the project; one of these citizens submitted petitions endorsing EPA funding of the project. No additional testimony was received.

Table 7-1 lists agencies and organizations to whom the draft EIS will be distributed. Public notices of the availability of this draft EIS and of a public hearing on the document and the related facilities plan will appear in the Federal Register and local newspapers. Copies of the draft EIS can be obtained from:

Clinton B. Spotts, Regional EIS Coordinator
U.S. Environmental Protection Agency, Region VI
1201 Elm Street
Dallas, Texas 75270
Telephone: (214) 767-2716

The draft facilities plan will be released at approximately the same time as the draft EIS and will be available for public review along with the draft EIS at the following locations:

Norman City Clerk's Office
201 West Gray
Norman, Oklahoma

Pioneer Multi-County Library
225 North Weoster
Norman, Oklahoma

Oklahoma State Department of Health
1000 Northeast 10th Street
Oklahoma City, Oklahoma

U.S. Environmental Protection Agency
1201 Elm Street
Dallas, Texas

The public hearing on the draft EIS will also cover the draft facilities plan.

TABLE 7-1. AGENCIES AND ORGANIZATIONS TO WHOM THE DRAFT EIS WILL BE DISTRIBUTED.

Listed below are government agencies and public interest groups which will receive a copy of the EIS. A number of individuals will also receive copies.

Federal Agencies

U.S. Department of the Interior
U.S. Fish and Wildlife Service
National Park Service
Bureau of Reclamation
U.S. Geological Survey
U.S. Department of Agriculture
U.S. Soil Conservation Service
Farmers Home Administration
Agricultural Stabilization and Conservation Service
U.S. Army Corps of Engineers
U.S. Public Health Service
Center for Disease Control
Federal Emergency Management Agency
Honorable David Boren, U.S. Senate
Honorable Don Nickles, U.S. Senate
Honorable Dave McCurdy, U.S. House of Representatives

State Agencies

State Department of Health
State Department of Pollution Control
Water Resources Board
Conservation Commission
State Department of Wildlife Conservation
State Geological Survey
State Department of Recreation and Tourism
State Department of Economic Development
State Department of Agriculture
State Historic Preservation Office
Corporation Commission
State Department of Energy
State Department of Transportation
Industrial Development Commission
Oklahoma Division of the Budget
Oklahoma State Clearinghouse
Governor George Nigh

Local Agencies

City of Norman
Norman City Council
Norman City Planning Commission
Norman Environmental Control Advisory Board
Central Oklahoma Master Conservancy District
Cleveland County Health Department
Norman Chamber of Commerce
Norman Facilities Plan/EIS Citizens Advisory Committee

Public Interest Groups

Sierra Club
National Wildlife Federation
Oklahoma Wildlife Federation
League of Women Voters
National Audubon Society
Oklahoma Lung Association
Oklahoma Trail Association
ACORN
Environmental Law Institute
Ozark Society, Inc.
Wildlife Management Institute
American Wildlife Alliance
Oklahoma Municipal League
Oklahoma State Home Builders Association
Oklahoma State Federation of Women's Clubs
American Association of University Women
Keep Oklahoma Beautiful
Oklahoma Ornithological Society
Oklahoma Coalition for Clean Air
Oklahoma Canoes Newsletter
Norman Developers Council
Norman Homebuilders Association

Other

Ozark Regional Commission
Pioneer Multi-County Library
Bizzell Memorial Library

CHAPTER 8

LIST OF PREPARERS

8. LIST OF PREPARERS

Name	Education	Years of Experience	Responsibility
Environmental Protection Agency			
Clinton B. Spotts	B.S., Agricultural Education	12	Regional EIS coordinator
Norm Thomas	B.S., Chemistry	5	Chief, EIS preparation section
Presley B. Hatcher	B.S., Biology	6	Norman EIS coordinator, public participation
John Cernero	B.S., Civil Engineering	10	Project engineer, Operations Section, Construction Grants Branch
Lee Wilson and Associates, Inc.			
Lee Wilson Principal	Ph.D., Geology	10	Project director; all sections; alternatives; water resources
Stevan Anderson Environmental Scientist	M.A., Geography	7	Physical environment; collection and treatment alternatives; graphics supervision
Catherine Callahan Environmental Scientist	M.S., Regional Planning and Environmental Studies	9	Construction impacts, mitigation
Ann Claassen Environmental Scientist	B.A., Chemistry	5	All sections; sludge alternatives; water resources; biology;
Carole Cristiano Environmental Scientist	M.U.A. Urban Affairs	6	Water supply

Diane Flock Environmental Scientist	B.A., Geography	10	Collection alternatives; population, land use, socio-economics; archaeeology, history
Natalie Keller Environmental Scientist	B.A., Biology and Geography	1	Air quality; energy and other resources
Eliza Niederman Environmental Scientist	B.A., Political Science	2	Graphics; energy and other resources
Elizabeth Hayden Technical Staff		1	Graphics
Robin Lake Technical Staff	B.F.A	8	Graphics
Betsy Bernat Administrative Staff		2	Word Processing
Marilyn Forrest Administrative Staff	M.A., Education	10	Word processing
Sally Rodgers Administrative Staff		18	Editing
Priscilla Visarraga Administrative Staff		5	Word Processing

Steve Flance and Associates

Steve Flance	M.S., Community Development	12	Land use

Additional Consultants

Mike Snavely	M.S., Biology	10	Water resources; biology

CHAPTER 9

BIBLIOGRAPHY

9. BIBLIOGRAPHY

ACOG, 1972. Economic and population study for central Oklahoma. Association of Central Oklahoma Governments, Oklahoma City, Oklahoma.

ACOG, 1976a. Water quality management evaluation, output 102bii, areawide waste management study. Association of Central Oklahoma Governments, Oklahoma City, Oklahoma.

ACOG, 1976b. Point source inventory, output 201ii, areawide waste management study. Association of Central Oklahoma Governments, Oklahoma City, Oklahoma.

ACOG, 1977a. Land use projections and analysis, output 102bi, areawide waste management study. Association of Central Oklahoma Governments, Oklahoma City, Oklahoma.

ACOG 1977b. Urban stormwater problem identification, phase I, outputs 302i and 302ii, areawide waste management study. Association of Central Oklahoma Governments, Oklahoma City, Oklahoma.

ACOG, 1977c. Urban runoff alternatives, output 303, areawide waste management study. Association of Central Oklahoma Governments, Oklahoma City, Oklahoma.

ACOG, 1977d. Point source problem identification, output 202, areawide waste management study. Association of Central Oklahoma Governments, Oklahoma City, Oklahoma.

ACOG, 1977e. A supplement to: Nonpoint source alternatives, output 402, areawide waste management study. Association of Central Oklahoma Governments, Oklahoma City, Oklahoma.

ACOG, 1977f. Alternative technical subplans and initial wasteload allocations, output 204b/205, areawide waste management study. Association of Central Oklahoma Governments, Oklahoma City, Oklahoma.

ACOG, 1981a. Report on wasteload allocation strategies. Association of Central Oklahoma Governments, Oklahoma City, Oklahoma.

ACOG, 1981b. Appendices: report on wasteload allocation strategies. Association of Central Oklahoma Governments, Oklahoma City, Oklahoma.

Adams, D.B. and P.G. Risser, 1973. Thunderbird Lake comprehensive plan, inventory and evaluation of the terrestrial environment. Division of State Parks, State of Oklahoma, Oklahoma City, Oklahoma.

AVCO, 1970. Storm water pollution from urban land activity. AVCO Economic Systems Corporation, a report for the Federal Water Quality Administration, Tulsa, Oklahoma.

Baxter, John, 1979. Sewage overflows at 2730 and 2736 Winding Creek Circle. Memorandum to James Crosby, dated May 18, 1979, City of Norman, Oklahoma.

Baxter, John, 1982. Personal communication. City engineer, City of Norman, Oklahoma.

Bingham, R.H., and R.L. Moore, 1975. Reconnaissance of the water resources of the Oklahoma City Quadrangle, Central Oklahoma. Hydrologic Atlas 4, Oklahoma Geological Survey, Oklahoma City, Oklahoma.

Bowman, David, 1982. Personal communication. U.S. Fish and Wildlife Service, Albuquerque, New Mexico.

Brown, J.T., 1982. Personal communication. Sanitarian for Cleveland County, Oklahoma State Department of Health, Norman, Oklahoma.

Buckhannon, W.H., 1954. Soil Survey, Cleveland County, Oklahoma. Series 1942, No. 7, U. S. Department of Agriculture - Soil Conservation Service, Washington, D.C., and Oklahoma Agricultural Experiment Station, Stillwater, Oklahoma.

Canter, L.W., 1973. Final report - environmental study of Little River State Park. Presented to Division of State Parks, State of Oklahoma, Oklahoma City, Oklahoma.

Carpenter, Charles, 1982. Personal communication. Prcfessor, Deaprtment of Zoology, University of Oklahoma, Norman, Oklahoma.

CEQ, 1978. Regulations for implementing the procedural provisions of the National Environmental Policy Act. Council of Environmental Quality, 43 FR 55978-56007, November 29, 1978; 40 CFR, parts 1500-1508.

City of Norman, 1972. Public works master plan. Norman, Oklahoma.

Clark, Dave, 1981. Personal communication. City Planner, Norman, Oklahoma.

Crowley, J.F. and W.C. Johnson, 1978. Investigation of land management land use study: Little River and Hog Creek arms of Lake Thunderbird. Division of State Parks, State of Oklahoma, Oklahoma City, Oklahoma.

DWR, 1972. Guidelines for erosion and sediment control planning and implementation. EPA-R2-72-015, prepared for U.S. Environmental Protection Agency by Department of Water Resources, Annapolis, Maryland.

ECAB, 1976. Unpublished report of the Noise Control Ad Hoc Committee to the Environmental Control Advisory Board, Norman, Oklahoma.

EE, 1974. Feasibility study - wastewater utilization through irrigation - advanced waste treatment - city of Norman, Oklahoma, April, 1974. Engineering Enterprise, Inc.

EPA, 1973. Comparative costs of erosion and sediment control: construction activities. Office of Water Program Operations, U.S. Environmental Protection Agency, Washington, D.C.

EPA, 1974. Information on levels of environmental noise requisite to protect public health and welfare with an adequate margin of safety. Project Number 550/9-74-004, U.S. Environmental Protection Agency, Washington, D.C.

EPA, 1977a. Draft environmental impact statement, Norman, Oklahoma. Project No. WPC-OKLA-505, U.S. Environmental Protection Agency, Dallas, Texas.

EPA, 1977b. Final environmental impact statement for Albuquerque wastewater treatment facilities, New Mexico. Project No. C-35-1020-01, U.S. Environmental Protection Agency, Dallas, Texas.

EPA, 1977c. Municipal sludge management: environmental factors. EPA 430/9-77-004, Municipal Construction Division, Office of Water Program Operations, U.S. Environmental Protection Agency, Washington D.C.

EPA, 1979. State and local assistance -- grants for construction of treatment works. U.S. Environmental Protection Agency, sub-part E, 40 CFR, part 35.

EPA, 1980. Evaluation of sludge management systems: evaluation checklist and supporting commentary. EPA 430/9-80, Office of Water Program Operations, U.S. Environmental Protection Agency, Washington D.C.

Fant, Richard, 1982. Personal communication. Code Enforcement Office, City of Norman, Oklahoma.

Frasier, Mike, 1981. Personal communication. Director of City Planning, Norman, Oklahoma.

Hall, R.W., et al., 1977. Arcadia Lake water-quality evaluation. Technical Report Y-77-2, Environmental Effects Laboratory, U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi.

Helmright, August, 1980. Personal communication. Cleveland County Health Officer, Norman, Oklahoma.

HUD, 1974. Flood hazard boundary map H-01-25, City of Norman, Oklahoma (Cleveland County). U.S. Department of Housing and Urban Development, Federal Insurance Administration, Washinton, D.C.

HUD, 1979. Flood insurance study, City of Norman, Oklahoma, Cleveland County. U.S. Department of Housing and Urban Development, Federal Insurance Administration, Washington, D.C.

Johnson, John C., 1957. Habitat preferences among representative wintering and breeding birds of the central Oklahoma forest-prairie ecotone. Master's thesis, University of Oklahoma, Norman, Oklahoma.

Lee, Chia-Lang, 1974. Sediment study of Lake Thunderbird. Master's thesis, University of Oklahoma, Norman, Oklahoma.

Lee, G. Fred, Walter Rast, and R. Anne Jones, 1978. Eutrophication of water bodies: Insights for an age-old problem. Environmental Science and Technology 12(8): 900-908.

LWA, 1980. Final environmental information document for city of Norman Bishop Creek relief sewers. Prepared by Lee Wilson and Associates, Inc., Santa Fe, New Mexico, for city of Norman, Oklahoma.

LWA, 1982. Information on file with Lee Wilson and Associates, 105 Cienega Street, Santa Fe, NM.

LWA, 1982a. Land use and water quality in the Little River basin, Oklahoma. Draft report prepared for the City of Norman and Region 6 of the U.S. Environmental Protection Agency, by Lee Wilson and Associates, P.O. Box 931, Santa Fe, NM.

Mitchell, Woodrow, 1982. Personal communication. Norman Chamber of Commerce, Norman, Oklahoma.

Moser, Byran, 1982. Personal communication. Chief, Game Management, Department of Wildlife Conservation, Oklahoma City, Oklahoma.

NC, 1981. Norman COMPLAN. City of Norman, Oklahoma.

NRC, 1978. Multimedium management of municipal sludge. Analytical studies for the U.S. Environmental Protection Agency, prepared by the National Research Council, National Academy of Sciences, Washington, D.C.

Novak, John T., et al., 1979. Effects of phosphorus supply on algal biomass in a turbid Missouri reservoir. Missouri Water Resources Research Center, University of Missouri, Columbia, Missouri.

ODA, 1979. Oklahoma agricultural statistics, 1979. Oklahoma Department of Agriculture, Oklahoma City, Oklahoma.

ODH, 1968. Geologic units of Cleveland County. Oklahoma Department of Highways, Oklahoma City, Oklahoma.

ODPC, 1979a. Water quality management plan for Little River (above Thunderbird Dam). Oklahoma Department of Pollution Control, Oklahoma City, Oklahoma.

ODPC, 1979b. Water quality management plan for Canadian River (Buckhead Creek to point 1.60 miles upstream of I-40 bridge). Oklahoma Department of Pollution Control, Oklahoma City, Oklahoma.

OSDH, 1980. 305(b) technical report. State Water Quality Laboratory, Environmental Health Services, Oklahoma State Department of Health, Oklahoma City, Oklahoma.

OSDH, 1980a. Standards for water pollution control facilities. Engineering Bulletin No. 0587, Water Facilties Engineering Service, Oklahoma State Department of Health, Oklahoma City, Oklahoma.

OSDH, 1980b. Oklahoma air quality report, 1980. Oklahoma State Department of Health, Oklahoma City, Oklahoma.

Painter, Pat, 1980. Personal communication. Painter and Spitz Consultants, Inc., Oklahoma City, Oklahoma.

PSC, 1979. Infiltration/inflow analysis, Norman, Oklahoma. EPA Project No. C-40-0899-01-0, Painter and Spitz Consultants, Inc., Oklahoma City, Oklahoma.

PSC, 1981. Draft facility plan, Norman Oklahoma. EPA Project No. C-40-0899-01-0, Painter and Spitz Consultants, Inc., Oklahoma City, Oklahoma.

PSC, 1982. Responses to the city of Norman staff comments on the draft facility plan. Painter and Spitz Consultants, Inc., Oklahoma City, Oklahoma.

Roach, W.R., 1974. A study of the non-point sources of pollution in the Little River drainage basin above Lake Thunderbird in Oklahoma. Master's Thesis, University of Oklahoma, Norman, Oklahoma.

SCS, 1979. Important farmlands map, Cleveland County, Oklahoma. U.S. Soil Conservation Service, U.S. Deptartment of Agriculture, Fort Worth, Texas.

Spotts, Clinton, 1979. Personal communication. Regional EIS Coordinator, U.S. Environmental Protection Agency, Region 6, Dallas, Texas, August, 1979.

Soil Survey Series, 1942. Soil survey, Cleveland County, Oklahoma. Soil Survey Series 1942, No. 7, U.S. Department of Agriculture, Soil Conservation Service, in cooperation with the Oklahoma Agricultural Experiment Station.

Sutton, George, 1980. Personal communication. Ornithologist, University of Oklahoma, Norman, Oklahoma.

Thorton, Mike, 1982. Personal communication. Oklahoma State Department of Health, Oklahoma City, Oklahoma, May 7, 1982.

URS, 1974. Water quality management planning for urban runoff. URS Research Company, report prepared for Environmental Protection Agency, National Technical Information Service, PB-241 689, Washington, D.C.

USBC, 1970. Characteristics of the population, Oklahoma, 1970. U.S. Bureau of the Census, Washington, D.C.

USDC, 1980. 1978 Census of agriculture, preliminary report, Cleveland County Oklahoma. U.S. Department of Commerce, Bureau of the Census, Washington, D.C.

USGS, 1976. Water resources data for Oklahoma, water year 1976, Vol. 2., Arkansas River basin. Water-Data Report OK-76-2, U.S. Geological Survey, Oklahoma City, Oklahoma.

Wade, William Frank, 1964. Preimpoundment fishery survey of Little River Reservoir of Cleveland County, Oklahoma. Bulletin No. 1, Oklahoma Fishery Research Laboratory, University of Oklahoma, Norman, Oklahoma.

Wells, Don, 1980. Personal communication. Appraiser, Norman, Oklahoma.

Wickersham, Ginia, 1979. Ground water resources of the southern part of the Garber-Wellington ground water basin, in Cleveland and southern Oklahoma Counties and parts of Pottawatomie County, Oklahoma. Hydrologic Investigations Publication 86, Oklahoma Water Resources Board, Oklahoma City, Oklahoma.

Wood, P.R., and L.C. Burton, 1968. Ground water resources in Cleveland and Oklahoma counties, Oklahoma. Circular 71, Oklahoma Geological Survey, Oklahoma City, Oklahoma.

Yanda, Leo, 1982. Personal communication. Associate Director, Architectural and Engineering Services, University of Oklahoma, Norman, Oklahoma.

CHAPTER 10

GLOSSARY

10. GLOSSARY

10.1 COMMON ABBREVIATIONS (ACRONYMS)

ACOG	Association of Central Oklahoma Governments
AF	Acre-feet
AFY	Acre-feet per year
BOD	Biochemical oxygen demand
BTU	British thermal units
CAC	Citizen's Advisory Committee
CEQ	Council on Environmental Quality
cfs	Cubic feet per second
COD	Chemical oxygen demand
COMCD	Central Oklahoma Master Conservancy District
COMPLAN	City of Norman Comprehensive Plan
CWA	Clean Water Act
DO	Dissolved oxygen
DU	Dwelling Unit
EID	Environmental Information Document
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency (U.S.)
ESP	Easily soluble phosphorus
g/day	Grams per day
gpcd	Gallons per capita per day
HUD	Housing and Urban Development (U.S. Department of)
I/I	Infiltration and inflow
kwh	Kilowatt hours
LS	Lift station
MGD	Million gallons per day
mg/g	Milligrams per gram
mg/l	Milligrams per liter
mg/m^3	Milligrams per square meter
N	Nitrogen
NEPA	National Environmental Policy Act
NPDES	National Pollutant Discharge Elimination System
O&M	Operation and maintenance
ODPC	Oklahoma Department of Pollution Control
OSDH	Oklahoma State Department of Health
OSHA	Office of Safety and Health Administration
OSS	On-site system
OWRB	Oklahoma Water Resources Board
P	Phosphorus
PCB	Polychlorinated biphenols
ppm	Parts per million
RBC	Rotating biological contactors
SCS	Soil Conservation Service (U.S.)
SHPO	State Historic Preservation Officer
STORET	Computerized data base operated by U.S. EPA

TDS	Total dissolved solids
TOC	Total organic carbon
TSS	Total suspended solids
ug/l	Micrograms per liter
ug/m^3	Micrograms per square meter
USBC	U.S. Bureau of the Census
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

10.2 TECHNICAL TERMS

Acre-foot. 1 acre-foot is the amount of water which covers one acre to a depth of one foot; equals 325,851 gallons or 43,560 cubic feet.

Acre-foot per year. Refers to the use or flow of one acre-foot of water in a year's time. This unit is used to quantify amounts of water rights.

Activated sludge. See extended aeration.

Advanced secondary treatment. Treatment more stringent than secondary treatment but not to advanced waste treatment levels (see definitions of secondary treatment and advanced waste treatment).

Advanced waste treatment. Treatment providing for discharges with BOD and TSS of less than 10 mg/l (each) and/or total nitrogen removal of greater than 50 percent.

Advisory Council on Historic Preservation. An independent executive agency empowered to comment upon all undertakings licensed, assisted or carried out by the Federal government that have an effect upon properties in the National Register of Historic Places.

Aerobic. An environment in which oxygen is present, or a chemical reaction in which the presence of oxygen is necessary.

Aerobic/anaerobic microorganisms. Microorganisms that either thrive on air (aerobic) or do not (anaerobic). Aerobic bacteria are more efficient at consuming organic matter while anaerobic bacteria produce humus and gases, such as methane.

Aeration. The process which brings about contact between air and water by natural or mechanical means such as spray, bubbling, or agitation.

Aquifer. An underground layer of permeable material that will yield sufficient water to be considered as a source of water supplies.

Algae. A class of plants containing chlorophyll which exist in ponds or other aquatic environments. The many varieties may have only single separate cells, or they may form clusters or threads. The green, blue or yellow scum on the water surface consists primarily of algae.

Anaerobic. An environment devoid of oxygen, or a chemical reaction which occurs in the absence of oxygen.

Biochemical oxygen demand (BOD). The oxygen demand of a sample of water is the amount of elemental oxygen required to react with oxidizable or biodegradable material dissolved or suspended in the sample. When the agency through which the oxidation is effected is a population of bacteria, the oxygen required is called the biochemical oxygen demand (BOD). BOD tests are usually run for 5 days, hence BOD_5. BOD load is the pollutant content of a body of water, usually expressed in pounds of oxygen required to break down the pollutants.

Bloom. A geometric increase in the rate of algae growth evidenced by the rapid appearance of vast numbers, matting, or floating filamentous (chain-like) masses.

Blue-green algae. Various species of single-cell microscopic algae with a blue-green hue which are generally considered undesirable due to appearance and smell.

Chemical oxygen demand (COD). (See BOD). A quick (and only approximate) measure of loads of oxidizable matter in water (in milligrams per liter) in which a strong oxidizing agent is used instead of microbial life. Like BOD, COD is an oxygen demand parameter; however, results cannot be used interchangeably with BOD values. COD can quickly identify water with very low or very high BOD potential.

Chlorination. The application of chlorine to water or wastewater, generally for the purpose of disinfection, but frequently for accomplishing chemical results, such as oxidation of odor-producing compounds.

Chlorine residual. Chlorine remaining in water or wastewater at the end of a specified contact period as combined or free chlorine.

Clarifiers. Mechanical devices for removal by gravity (settling out) of suspended particles in a liquid such as sewage.

Codisposal. Refers to a sludge disposal option, in which sludge is mixed with municipal refuse and incinerated; the energy thus produced is recovered (e.g. as electricity).

Cogeneration. Refers to using heat from the coincineration process to produce both electricity and steam.

Collection system. Pipelines or conduits, pumping stations, force mains, and all other devices, appurtenances and facilities used for collecting and conducting waste to a point of treatment and disposal.

Comprehensive land use plan. A long range comprehensive plan providing for the future growth and development of an area and seeking to project a concept under which the community may be developed in an orderly and desirable fashion.

Conductivity. The ability to carry an electrical charge, in ions. The conductivity of aqueous solutions is increased by dissolved salts and thus is a measure of the amount of ionized salts in solution.

Consumption. The amount of diversion of water not consumed, but returned back to the stream; also called discharge.

Critical habitat. Any land, air or water area including any elements thereof which the Secretary of Interior under the provisions of the Endangered Species Act has determined is essential to the survival of wild populations of a species listed as endangered or threatened or to its recovery to a point at which it needs no longer be protected.

Cubic feet per second (cfs). Units used to measure flow at a gaging station; equals the rate of flow in a channel with a one-square-foot cross-section and velocity of one foot per second. One cfs for a 24-hour period equals 86,4000 cubic feet or 1.98 acre-feet.

Dewatering. A process which removes enough of the water from sludge so that it behaves as a solid (greater than 15% solids).

Digester. In a wastewater treatment plant, a closed tank that decreases the volume of solids and stabilizes raw sludge by bacterial action.

Discharge volume. The quantity of liquid flowing per unit of time in a stream channel, conduit, or orifice at a given point.

Discharge plan. A description of methods and conditions, including any monitoring and sampling requirements, for the discharge of effluent or leachate which may move directly or indirectly to surface or ground water.

Dissolved air flotation. A process for thickening of sludge. Pressurized air is fed into the sludge from below; air bubbles attach to sludge particles and buoy them to the surface where they are scraped off as thickened sludge. Used primarily with waste activated sludge; produces a sludge with 4 to 8% solids.

Dissolved oxygen (DO). DO concentration of unpolluted water depends primarily on atmospheric pressure and temperature. Therefore, it is greater at sea level and when water is cool than at high altitudes or when water is warm. In the course of breaking down excess organic matter in water, microbes may deplete the oxygen, causing stress to fish and other aquatic life. In extreme depletion, water may become anaerobic (literally without air) stagnate, and stink.

Diversions. The amount of water taken from a stream (or spring or well); also called withdrawals.

Ecology. Refers to the relationship between living organisms and the environment.

Effluent. Wastewater or other liquid, partially or completely treated, flowing out of a reservoir, basin, treatment plant, or part thereof.

Effluent limitation. Any restriction established by a state or EPA on quantities, rates, and concentrations of chemical, physical, biological, and other constituents which are discharged from point sources into navigable waters, the waters of the contiguous zone, or the ocean.

Endangered Species. Any species which the Secretary of Interior has designated as being in danger of extinction throughout all or a significant portion of its range other than a species of the class insecta determined by the Secretary of Interior to constitute a pest whose protection would present overwhelming and overriding risk to man.

Environmental Impact Statement (EIS). A report prepared by a federal agency, such as EPA, which identifies and analyzes in detail the environmental impacts of a proposed action and feasible alternatives. Under the National Environmental Policy Act (NEPA), the report is required for all major federal actions that will have a significant effect on the quality of the human environment.

Environmentally significant agricultural land. Land that has a suitable combination of physical and chemical characteristics for producing food, feed, forage, fiber and oil seed crops, and is also available for these uses. It has soil quality, growing season and moisture supply needed to economically produce sustained high yields of crops when treated and managed.

Eutrophic. A period in the life of a lake characterized (in the prototype setting) by increased nutrients, a great amount of biological activity, and algae blooms.

Extended aeration. A method of treating sewage involving 24 hours of mechanical aeration in a tank to introduce oxygen and support aerobic bacteria feeding on the organic matter in the sewage. In the subsequent settling stage, the mass of bacteria drop out to form a sludge. A portion of this "activated" sludge is recycled for treatment of fresh sewage.

Facilities plan. Preliminary plan prepared by the grantee as the basis for a construction grant for publicly owned treatment works. Specific requirements for these plans appear in 40 CFR Part 35.

Fecal coliforms. A large and varied group of bacteria. The fecal coliform bacteria flourish in the intestines and feces of warm-blooded animals, including man. Escherichia coli (E. coli) is largely of fecal origin and has been the indicator organism most commonly cited as indicating sewage or feedlot pollution. The coliforms usually do not themselves cause disease, but their presence in water suggests that disease-causing organisms (pathogens) may also be present. Coliform bacteria are used as indicators of pollution because they are abundant and their presence is fairly easy to detect. The coli-aerogenes group is also among indicator organisms and is not usually distinguished from other fecal coliforms. Enteric viruses are pathogens found in animal wastes. Methods for their identification in water remain provisional. The presence of fecal coliform bacteria suggests that pathogenic and viruses may be present--hence the concern over danger of bacterial infection whenever large numbers of fecal coliform bacteria are detected in water.

Fish kill. Situation in which a large number of fish die in a short period of time, generally due to either a lack of dissolved oxygen or to some toxin which is introduced into the water.

Force main. A pressure pipe joining the pump discharge at a water or wastewater pumping station with a point of gravity flow.

Grit. The heavier mineral matter, such as sand, gravel, etc., in water or sewage.

Ground water. Interstitial water which occurs in saturated earth material and which is capable of entering a well in sufficient amounts to be utilized as a water supply.

Heavy metals. Metals of higher atomic weight which are generally insoluble, tend to collect in the environment, and at higher concentrations are generally toxic, such as lead, silver, cadmium and mercury.

Herbicide. A substance toxic to plants which is used to control weeds.

Hypolimnion. In a stratified lake, the lower strata which is usually colder and more dense than the upper strata (epilimnion).

Impact. Any change, beneficial or detrimental, that is caused, directly or indirectly, by the construction of wastewater treatment facilities.

Incineration. A sludge disposal option in which the sludge is burned in a furnace. Usually requires additional fuel.

Interceptor. Trunk line, usually at least 12" in diameter, which carries wastewater from smaller collection lines to the treatment plant.

Influent. Raw or partially treated wastewater flowing into a sewage treatment plant.

Larvae. Earliest stage of insect development.

Lift station. A small wastewater pumping station that lifts the wastewater to a higher elevation when the continuance of the sewer at reasonable slopes would involve excessive depths of trench, or that raises wastewater from areas too low to drain into available sewers. These stations may be equipped with pneumatic ejectors or centrifugal pumps.

Macroplankton. Plankton that are easily visible to the eye.

Microplankton. Plankton that can be seen only with the help of a microscope.

Milligrams per liter (mg/l). One part by weight of dissolved chemical, or suspended sediment, in 1 million parts by volume (= 1 liter) of solvent (usually water or air). See Parts per million.

Million gallons per day (mgd). A unit of measurement for expressing the flow rate of sewage treated at a plant.

Monitoring. Periodic or continuous determination of the amount of pollutants present in or discharged to the environment.

National Pollutant Discharge Elimination System (NPDES). The National water discharge permitting system authorized under section 402 of the Clean Water Act, including any state or interstate program which has been approved by the Administrator, in whole or in part, pursuant to Section 402.

National Register of Historic Places. A register of districts, sites, buildings, structures and objects significant in American history, architecture, archeology and culture. The National Register is maintained by the Secretary of Interior and is published in its entirety in the FEDERAL REGISTER each year in February. Addenda are published on the first Tuesday of each month.

National Environmental Policy Act of 1969 (NEPA). Federal law enacted to ensure that all Federal agencies include in the decision-making process appropriate and careful consideration of all environmental effects of proposed actions, explain potential environmental effects of proposed actions and their alternatives for public understanding, avoid or minimize adverse effects of proposed actions, and restore or enhance environmental quality as much as possible.

Nitrogen. See Nutrient.

Nonpoint source. A type of pollution that cannot be pinpointed to a specific source, or pollution whose source is general rather than specific in location (e.g., agricultural lands). See Point source.

Nutrient. An element or compound required by an organism for growth and/or sustenance. Commonly, when referring to water quality, "nutrient" specifically means phosphorus and/or nitrogen.

Oligotrophic. A period in the life of a lake characterized low nutrient content, as contrasted to eutrophic.

On-site systems (OSS). Individual facilities for treatment and disposal of wastewater (e.g., septic tanks), as opposed to a public wastewater treatment facility.

Oxidation process. Any method of wastewater treatment for the oxidation of the putrescible organic matter. The usual methods are bioligical filtration and the activated sludge process.

Oxidation treatment. The process whereby, through the agency of living organisms in the presence of oxygen, the organic matter contained in wastewater is converted into a more stable or mineral form.

Oxidation tower. A vertical trickling filter, where synthetic media are encased in a tower and effluent trickles down from the top.

Parts per million (ppm). One part by weight of dissolved chemical, or suspended sediment, in 1 million parts by weight of solvent (usually water or air). For aqueous (water) solutions, parts per million and milligrams per liter are nearly equivalent.

pH. The acidity of alkalinity of water depends on the hydrogen-ion activity (which is approximately equal to the hydrogen-ion concentration). pH is a measure of this activity. A pH above 7 indicates alkalinity; below 7, acidity; pH 7 is neutral.

Photosynthesis. Process of the formation of carbohydrates by living plants under the influence of sunlight.

Phosphorus. See Nutrient.

Phytoplankton. The plant portion of plankton.

Plankton. A collective term referring to organisms which live suspended in the water of a water body.

Point source. Any discernible, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operations, or vessel or other floating craft, from which pollutants are or may be discharged.

Primary treatment. The initial, physical treatment of sewage, such as by sedimentation (settling out of solid material), screening, etc.

Recharge Areas. An area in which water is absorbed and eventually reaches one or more aquifers.

Return flow. The amount of diversion water not consumed, but returned back to the stream; also called discharge.

Rotating biological contactor. An oxidation method (see oxidation process) whereby sewage-consuming organisms are grown on the artificial media of a rotating drum which is at all times half submerged in the wastewater.

Secondary treatment. Treatment level meeting effluent limitations for BOD and TSS of 30 mg/l (each) on a maximum monthly average basis. Secondary treatment removes virtually all floating and settleable solids and most BOD and TSS from the wastewater.

Septic wastewater. Wastewater in which material is undergoing decomposition under anaerobic conditions.

Settleable solids. The matter in wastewater which will not stay in suspension during a preselected settling period, such as one hour, but either settles to the bottom or floats to the top.

Sewage. A combination of liquid and water-carried wastes from residences, commercial buildings, industrial plants and/or institutions; wastewater.

Sewer system. Pipelines, conduits, pumping stations, force mains, or other structures, devices, appurtenances or facilities used for collecting or conducting wastes to an ultimate point for treatment or disposal.

Sewerage system. A system for disposing of wastes, either by surface or underground methods, and includes sewer systems, treatment works, disposal wells and other systems.

Sludge. A concentrate in the form of a semi-liquid mass deposited as a result of the treatment of sewage.

Stabilization. Treatment of sludge so that it can be disposed of without creation of undue nuisance conditions or environmental damage, measured by parameters such as odor, microbiological activity, toxicity, etc.

Sulfate. The sulfate ion is one of the major anions occurring in natural waters. Sulfate has a laxative effect upon humans when it is present in excessive amounts. For this reason, the U.S. Public Health Service Standards recommend an upper limit of 250 mg/l in waters intended for human consumption. Waters containing appreciable amounts of sulfate tend to cause odor and corrosion problems.

Threatened Species. Any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

Thickening. A process which increases the solids content of sludge (up to 15%, at which point the sludge is still a liquid), and thus reduces the volume which must be handled.

Total dissolved solids (TDS). Theoretically, the anhydrous residues of the dissolved constituents in water. Actually, the term is defined by the method used in determination. In water and wastewater treatment, the Standards Methods tests are used.

Total organic carbon (TOC). A direct measure of carbon, which is the major constituent of organic matter. Unlike BOD and COD which are indirect measures of organic matter, TOC can be used successfully as an organic load parameter.

Total suspended solids (TSS). The sum of the solids which either float on the surface or are in suspension in water, wastewater, or other liquids, and which are largely removeable by laboratory filtering, usually stated in milligrams per liter.

Turbidity. Defined as capacity of material suspended in water to scatter light. Measured in arbitrary Jackson turbidity units (JTU) or, more recently, Formazin turbidity units (FTU). Highly turbid water is often called "muddy," although all manner of suspended particles contribute to turbidity.

208 planning area. Area designed for regional wastewater management planning, including point and non-point sources.

Wastewater. The spent water of a community. A combination of liquid and water-carried wastes from residences, commercial buildings, industrial plants and/or institutions; sewage.

Wetland. An area that is inundated by surface or ground water with a frequency sufficient to support vegetative or aquatic life that requires saturated soil conditions.

Zooplankton. The animal portion of plankton.

10.3 METRIC CONVERSIONS

To facilitate the public use of this report, English units are used throughout the EIS. These units may be converted to metric units by using the following conversion factors. For example, to convert a distance of 5 miles to kilometers multiply 5 by 1.6044; the result is 8.05 (or about 8) kilometers.

English Unit		Metric Equivalent and Abbreviation
	Length	
1 inch	=	0.02540 meters (m)
	=	2.540 centimeters (cm)
1 foot	=	0.30480 meters (m)
1 mile	=	1.6094 kilometers (km)
	Volume	
1 U.S. gallon	=	3.7853 liters (l)
	=	0.00379 cubic meters (m^3)
1 cubic foot	=	0.02832 cubic meters (m^3)
1 acre-foot	=	1233.5 cubic meters (m^3)
	Weight	
1 pound	=	0.4536 kilograms (kg)
	=	453.59 grams (g)
	Area	
1 acre	=	0.4047 hectares (h)
	=	0.004047 square kilometers (km^2)
1 square mile	=	2.5900 square kilometers (km^2)
	Volumetric Flow	
1 cubic foot per second	=	0.02832 cubic meters per second (m^3/sec)
1 millions gallons per day	=	3785.3 cubic meters per second (m^3/sec)

Temperature

Temperature in degrees Celsius (^oC) can be converted to temperature in degrees Farenheit (^oF) by the following formula:

$$(^oF) = 1.8\ (^oC) + 32$$

APPENDIX A

EXISTING WASTEWATER MANAGEMENT

APPENDIX A. EXISTING WASTEWATER MANAGEMENT

Table of Contents

		Page
Table A-1.	Description of existing facilities, Norman	A- 2
Table A-2.	Water quality, South Canadian River, July 1980	A- 7
Table A-3.	Water quality, South Canadian River, October 1980	A- 8
Table A-4.	Composite wastewater characteristics	A- 9
Table A-5.	Summary of minimum requirements for individual sewage disposal systems	A-10
Figure A-1.	Existing wastewater treatment plant	A-11

TABLE A-1. DESCRIPTION OF EXISTING FACILITIES.

1. Collection System

Basins. See Figure 5-1 for present extent of service areas and for location of sewerage service basins. The sewer systems south and west of the ridge line are divided into 3 drainage basins. Basin A collects sewage from western Norman and conveys it to the treatment plant along a large interceptor sewer which lies near the South Canadian River. Basin B collects sewage from central Norman and uses interceptors which follow the natural drainage of Imhoff Creek, roughly parallel to Berry Road. The Bishop Creek drainage, Basin C, collects sewage from eastern Norman, and uses interceptors which generally follow the natural drainage of Bishop Creek, roughly parallel to Jenkins Avenue. North and east of the ridge line is Basin D. Wastewater from the Westinghouse and Vo-Tech lift stations of Basin D is pumped into Basin A. Industrial and Crystal Heights lift stations pump wastewater into Basin B. Wastewater from Woodcrest lift station is pumped into Basin C.

Lines. The existing collection system consists of approximately 242 miles of sanitary sewer lines in the lengths and sizes shown below.

SIZES AND LENGTHS OF SEWER LINES

DIAMETER	LENGTH (Feet)	PERCENT OF TOTAL SYSTEM
4"	4,350	0.3
6"	158,098	12.3
8"	783,282	61.2
10"	91,970	7.2
12"	78,385	6.1
15"	19,915	1.6
18"	51,975	4.1
21"	39,742	3.1
24"	26,905	2.1
30"	6,825	0.5
36"	2,270	0.2
39"	10,825	0.8
42"	5,800	0.5
TOTAL	1,280,342	100.0

Problems. The system experiences many problems at this time (EPA, 1977a), mostly related to excessive inflow of surface water and to age. These problems are especially evident in Basins B and C. Rapid post-war growth resulted in much branching and paralleling of the main outfalls, which "is the result of incremental growth without preplanning", according to the city's Public Works Master Plan (City of Norman, 1972). The regional wastewater management plan noted that sewers in older parts of the city are "severely deteriorated in places" (ACOG, 1976b). The report also notes system overflows (in particular the line serving the Central State Hospital) which are related to significant storm events. Such overflows may be the result of infiltration/inflow to deteriorated pipes. Exfiltration is also a problem, and manifests itself in flooded basements. Overflows and odors from clogged or slow lines result from undersizing, overuse, and/or inadequate grade.

Experience indicates that many existing sanitary sewer trunk lines were not sized to accommodate the total potential development within a drainage basin. As the time of construction, either one or a combination of the following conditions could have existed: per capita design figure was too low; there was a shortage of money; additional development within the drainage basin was not anticipated; anticipated residential densities were lower than actual development. In turn, water infiltration, inadequate grade, settling of a line, and improper taps into the line may have reduced the actual capacity as originally provided.

TABLE A-1. (Continued)

2. Significant Dischargers

The 208 water quality managment plan for central Oklahoma lists four "significant" contributors which discharge over 50,000 gpd to the Norman sewer system: Westinghouse Corporation, Gilt Edge Farms, Central State Hospital, and the University of Oklahoma (ACOG, 1977f). The 208 Point Source Inventory (ACOG, 1976b), did not identify any adverse effects to the treatment process from industrial contributors. Grab sample analyses done for the city tend to confirm this finding, except for very high organic flows from Gilt Edge Dairy. Flows from the hospital are much higher and more variable than expected, due to infiltration/inflow and/or unidentified discharges from the hospital. In the past, sewer service to the hospital was free; however, settlement of a recent suit now requires remuneration.

3. Lift Stations

Norman has ten wastewater pump stations located in the collection system. All pump stations except Woodcrest were in good operating order during the study period; Woodcrest had only one pump operating during the study. That pump has since been replaced and a standby pump was also installed.

LIFT STATION	RATED CAPACITY	ACTUAL CAPACITY
Brookhaven	100 gpm	100 gpm
Crestmont	250 gpm	east 229 gpm
		west 284 gpm
Crystal Heights	-	120 gpm
Industrial	60 gpm	50 gpm
Treatment Plant	530-2,200 gpm	530-2,200 gpm
Vo-Tech	200 gpm	200 gpm
Westinghouse	600 gpm	600 gpm
Woodcrest	165 gpm	155 gpm
Rock Creek Polo Club	approx. 150 gpm	-
Norman Research Park (lifts to total retention lagoon)	approx. 120 gpm	-

4. Treatment Plant Facilities

Figure A-1 shows the layout of the treatment plant The plant was expanded and renovated in 1972 at a cost of about $4,000,000, including federal grants. Hydraulic and biologic treatment capacities are for an average flow of 10.0 MGD (100,000 persons per day) and a maximum flow of 20.0 MGD. The treatment plant has the capacity to provide primary treatment for 40.0 MGD. Sludge equipment can accommodate only 70,000 persons per day by design, and the aerobic digestion system has performed poorly since completion of the plant, so that its capacity in this regard has already been exceeded.

Essential elements of the treatment system include: comminutors; aerated grit chamber; four primary clarifiers; two biological towers; two trickling filters; intermediate clarifier; aerated lagoon; two final clarifiers; chlorinator. Effluent is chlorinated and discharged to the South Canadian River.

Sludge is processed by two gravity thickeners, two anaerobic digesters, one aerobic digester with a decant clarifier, sludge drying beds and a liquid sludge applicator. The digested sludge from the anaerobic digesters is applied to land by sub-surface injection. The aerobically digested sludge is dewatered in the sludge drying beds and subsequently used as soil conditioner. The sludge drying beds have a dewatering capacity to serve a population equivalent to 70,000 persons.

TABLE A-1. (Continued)

5. Plant Performance

Norman's NPDES permit number OK0029190 was issued effective April 24, 1981, and will expire on April 23, 1986. Requirements of the permit are listed below.

	Unit of Measurement	Effluent Concentrations 30-day Average	 7-day Average	Effluent Loading 30-day Average (BOD5)
Biochemical Oxygen Demand (5-day)	mg/l	20	30	757 kg/day 1668 lbs/day
Suspended Solids (SS)	mg/l	30	45	1135 kg/day 2502 lbs/day
Fecal Coliform Bacteria	number/100 ml	200	400	

Tables A-2, A-3 and A-4 provide water-quality and effluent data related to plant performance. Plant effluent (four-year average) contains 22 mg/l BOD (92% removal) and 13 mg/l SS (92% removal) through occasional upsets do occur (refer to the Glossary, chapter 10, for explanation of terms).

Under current conditions at the treatment plant, Norman can not consistently comply with the NPDES effluent requirements. While receiving 15,000-16,000 pounds of BOD per day, the plant can adequately treat only 10,560 pounds per day due to the poor performance of the rock filters (secondary filters) and the inefficiency of the aerated lagoon (PSC, 1981).

Issuance of the NPDES permit was accompanied by EPA Administrative Order (AO) VI-81-714. The AO recognizes the inability of the plant to consistently meet permit requirements and lists interim requirements effective until the permit can be met through upgrading of facilities. The interim requirements allow a maximum BOD of 2502 lbs/day, or 30 mg/l as a 30-day average, and 45 mg/l as a 7-day average. The AO also requires that Norman submit a completed facilities plan to the State by January 6, 1982, and submit a Step 2 application by February 18, 1982. It is expected that the AO will be modified to reflect the 1981 amendments to the Clean Water Act (which eliminated the 'Step' process).

The performance of individual treatment units is examined below (extracted from PSC, 1981).

Headworks: The communities have adequate capacity to handle both existing and projected flows. However, higher water elevations in the aerated grit chamber and the Parshal Flumes downstream cause backup in the influent sewers. To prevent septic conditions of the influent wastewater, low lift pumps are required prior to the headworks.

Aerated Grit Chamber (Preaeration): The grit chamber can provide adequate air mixing and detention time for grit removal purpose at existing and projected flow conditions.

Primary Clarifiers: The primary clarifiers have the capacity to adequately treat a maximum flow of 20.0 MGD (maximum hourly flow). The BOD removal efficiency is slightly lower than the normal range (30 to 35 percent).

Two-Stage Trickling Filters: The first-stage filters (plastic media towers) operate effectively, yielding adequate BOD removal efficiency. The second-stage filters (rock filters) have very poor performance in BOD reduction.

TABLE A-1. (Continued)

Aerated Lagoon and Final Clarifiers: According to laboratory results on November 18 and 19, 1980, the aerated lagoon provides no additional removal of BOD from the trickling filter effluent. Algal growth and "dead spots" have been observed in the lagoon. The final clarifiers are not effective in reduction of BOD from the lagoon effluent. The existing piping system does not permit bypassing of the aerated lagoon to let the wastewater flow from the secondary filters to the final clarifiers.

Solids Handling Capacity: The anaerobic digesters are functioning adequately at present conditions. Some operational problems with the aerobic digestion system have been observed, such as poor settleability of sludge in the decant clarifier, resulting in losses of solids to the secondary pump station wet well.

The aerobic and anaerobic digesters have a total capacity to treat 8,000 lbs of volatile solids per day. The present sludge production is about 85 percent of the full capacity of the digesters. Since the digesters are presently operating near their full capacity, expansion of the sludge treatment system at the plant is required to meet future demands. A full-scale plan for sludge disposal should be developed to determine the most cost-effective solution for Norman's sludge treatment and disposal system.

Conclusions: Even though the existing treatment facility has the hydraulic capacity to accommodate a maximum flow of 20.0 MGD, the final effluent at the present average flow of 6.3 MGD does not consistently meet the NPDED limitations in terms of BOD_5 concentration. Upgrading of the existing treatment plant is required in order to bring the facily in compliance with the NPDES permit, under both present and projected hydraulic and organic loadings.

The primary clarifiers have adequate capacity to treat a maximum hourly flow of 20.0 MGD and are able to provide removal efficiency of BOD and TSS within an acceptable range.

The secondary treatment units cannot operate satisfactorily to meet NPDES effluent limitations due to poor performance of the secondary filters and total inefficiency of the aerated lagoon.

As for solids handling, alternative treatment and disposal methods should be examined to determine the most cost effective and energy-efficient solution for the needs of the Norman treatment facility.

6. Costs; Staff

Annual operating costs are about $331,995. $203,185 is for personnel, $96,700 is for electricity and the remaining $32,110 is for other operation and maintenance. A staff of 18 working on three shifts is required at present to run the plant.

7. Problems

A number of problems involve upkeep of the plant, including most notably general maintenance, operating problems and odors. The following list provides a summary.

Maintenance:

- repairs of positive displacement pumps are frequent;
- higher than expected maintenance of new screw-type lift pumps;
- difficulty in servicing large, heavy pumps;
- inability to drain or circumvent treatment units for cleaning or repairs.

TABLE A 1. (Continued)

Operation:

- totally inoperative effluent measurement system:
- high energy costs due to high pumping and aeration demands;
- dead spots in the aerated lagoon;
- sludge accumulation on the sloped walls of the final clarifier;
- inadequate settling in secondary clarifier, even with addition of floculants;
- periodic algal blooms in the polishing pond and final clarifiers.

Odors:

- the problem of septic wastewater entering the plant (due to surcharging behind the entrance works) has recently been corrected, significantly reducing odors;
- digester problems (supernatant sent from primary digesters to primary clarifiers);
- periodic bacterial growth and resulting odors from polishing pond.

Most of these problems are interrelated. The facility is a hybrid of several plants and treatment processes which span decades and several engineering firms. Add-on units, tied together with lift stations at three points within the plant, in addition to numerous pumps and aerators of different ages and types, have burdened the plant with a large and expensive maintenance and energy demand.

Sources: Files of Painter and Spitz Consultants, Inc., Oklahoma City, Oklahoma, and City of Norman, Oklahoma.

TABLE A-2. WATER QUALITY, SOUTH CANADIAN RIVER (SCR), JULY, 1980. Note: stations SCR-3 and SCR-4 are above and below the Norman wastewater treatment plant.

STATION	Flow (cfs)	Temp. (°F)	Adjusted UOD[d] (mg/l)	Ammonia Nitrogen (mg N/l)	Nitrite+ Nitrate-Nitrogen (mg N/l)	Ortho-phosphate Phos-phorus (mg P/l)	Chloro-phyll-a (ug/l)	Travel Time (days)[a]	Dissolved Oxygen (mg/l) Max.	Min.	Ave.	Reach/ Mile	Chromium (ug/l)	Lead (ug/l)	Fecal Colifor (cells/100ml)
SCR-1	16.7	85	30.5	0.1	0.1	0.05	49	b	7.3	3.2	5.4	1/38.5	10	20	1,800
SCR-2	18.3	86	33.6	0.1	0.1	0.10	92	b	8.5	2.5	5.7	1/32.5	10	20	5,300
SCR-3	15.4	87	38.0	0.1	0.1	0.08	94	--	8.6	2.5	5.4	2/24.5	10	20	3,700
SCR-4	25.3	87	43.7	0.3	4.7	0.78	110	0.97	11.4	5.1	8.3	3/14.0	10	20	8,400
SCR-5	25.4	88	44.3	0.3	3.0	0.37	142	2.98	14.8	5.1	9.6	4/7.5	10	20	11,100
SCR-6	24.3	88	33.7	0.1	0.1	0.18	326	c	14.4	5.4	10.1	5/0.0	10	20	4,800
Moore WWTP	5.6	86	110.0	12.6	0.2	7.0	215	--	5.0	1.0	2.5	1/34.0	10	20	77,500
Norman WWTP	10.2 [illegible]	84	60.7	1.6	23.5	8.8	2	--	5.3	3.0	4.1	3/22.5	10	20	800
Noble N. WWTP	1.0	83	116.4	3.5	7.4	9.6	25	--	1.1	0.2	0.7	3/18.5	16	25	33,000
Noble S. WWTP	N/D	N/D	N/D	N/D	N/D	N/D	N/D	--	N/D	N/D	N/D	3/17.0	10	20	120,800
Lexington WWTP	0.2	82	16.8	0.2	4.3	8.1	2	--	6.8	3.0	4.0	5/7.0	10	20	110,000
Purcell WWTP	0.6	91	116.5	2.0	0.1	2.0	171	--	12.2	4.1	8.1	5/5.0	10	20	305,300

[a] Travel study was conducted at different time in July at much lower flow regime.

N/D = No Discharge

[b] Canadian River dried up between SCR-1 and SCR-3 before dye study could be completed. Travel times are calculated from Norman WWTP.

[c] No Data

[d] Ultimate Carbonaceous Oxygen Demand

SOURCE: ACOG, 1981b.

TABLE A-3. WATER QUALITY, SOUTH CANADIAN RIVER (SCR), OCTOBER, 1980. Note: stations SCR-3 and SCR-4 are above and below the Norman wastewater treatment plant.

STATION	Flow (cfs)	Temp. (°F)	Adjusted UOD[c] (mg/l)	Ammonia Nitrogen (mg N/l)	Nitrite+ Nitrate-Nitrogen (mg N/l)	Ortho-phosphate Phosphorus (mg P/l)	Chlorophyll-a (ug/l)	Travel[b] Time (days)	Dissolved Oxygen (mg/l)			Reach/ Mile	Chromium (ug/l)	Lead (ug/l)	Fecal Coliform (cells/100ml)
									Max.	Min.	Ave.				
SCR-1*	0.44	74	43.8	0.1	2.0	5.0	445	--	14.4	4.9	8.8	1/38.5	--	--	1,070
SCR-2	2.32	74	63.9	11.4	1.0	7.9	236	--	17.2	5.3	12.2	1/32.5	--	--	2,400
SCR-3	0.03	72	17.4	0.1	0.1	0.2	22	--	11.6	6.4	8.8	2/24.5	--	--	186
SCR-4	5.78	71	49.6	5.1	6.5	8.5	24	--	18.2	4.0	10.9	3/14.0	--	--	230
SCR-5	1.11	70	50.2	0.1	2.4	2.8	68	--	17.2	5.0	8.8	4/7.5	--	--	650
SCR-6**	0.59	***	38.8	0.1	0.1	0.7	384	--	***	***	***	5/0.0	--	--	---
Moore WWTP	4.87	71	112.2	22.3	0.1	10.7	200[a]	--	5.0	1.0	2.2	1/34.0	--	--	250,000
Norman WWTP	9.91	72	63.2	12.2	8.6	9.4	2[a]	--	9.0	3.0	5.1	3/22.5	--	--	150
Noble N. WWTP	1.35	70	44.6	3.4	22.8	11.8	2[a]	--	6.0	1.0	3.7	3/18.5	--	--	100,000
Noble S. WWTP	0.41	71	78.4	0.1	3.4	3.6	1034	--	15.0	0.8	5.5	3/17.0	--	--	149,000
Lexington WWTP	0.15	71	21.4	1.0	4.2	8.2	2	--	5.0	0.2	2.4	5/7.0	--	--	2,100
Purcell WWTP	0.37	71	114,1	10.4	0.6	3.4	314	--	14.0	1.0	7.4	5/5.0	--	--	42,000

---

[a] Estimated

*Station moved to location on tributary above Moore WWTP discharge point.

**Station moved to location 2 miles downstream from SCR-5.

***Insufficient data.

[b] Time-of-travel study not continuous due to relocation of stations and disappearance of flow in certain reaches.

[c] Ultimate Oxygen Demand

SOURCE: ACOG, 1981b.

TABLE A-4. COMPOSITE WASTEWATER CHARACTERISTICS AND COMPOSITION, NORMAN WASTEWATER TREATMENT PLANT, NOVEMBER 18-19, 1980. Note: daily flow was 6.65 mgd.

Parameter	Influent†	Canadian River Upstream of Plant	Canadian River After Asphalt Plant	Canadian River Downstream of Plant
Solids, Total	697.9	448.7	455.5	469.8
Solids, Suspended	204.4	22.1	35.9	17.7
Solids, Suspended Volatile	167.5	12.7	13.4	11.7
Solids, Settleable**	7.75	0.	0.	0.
Solids, Dissolved	493.4	426.5	419.6	452.1
Biochemical Oxidation Demand	194.	10.	5.	5.
Chemical Oxidation Demand	425.	38.	35.	38
Dissolved Oxygen	0.8	10.7	9.7	9.0
pH*	7.3	8.0	8.0	7.5
Phosphate as Phosphorus	8.25	4.33	4.33	7.57
Nitrate-Nitrogen	2.5	0.5	0.4	8.4
Nitrite-Nitrogen	0.016	0.065	0.075	3.98
Ammonia-Nitrogen	14.7	3.20	2.25	8.20
Organic Nitrogen	19.9	2.99	1.94	4.42
Phenol	0.002	<0.001	<0.001	≤0.001
Cyanide	0.013	<0.001	<0.001	<0.005
Fecal***	190.000.	0.	0.	0.
Chromium, hexavalent	0.020	≤0.005	≤0.005	≤0.005
Chromium, total	0.022	<0.005	≤0.005	<0.005
Lead	0.025	<0.010	<0.010	<0.010
Zinc	0.114	0.025	0.033	0.032
Mercury****	<0.005	<0.005	<0.005	<0.005
Copper	0.044	0.008	0.011	0.011
Iron	0.897	0.570	1.217	0.349
Cadmium	<0.0005	<0.0005	<0.0005	<0.0005
Nickel	0.007	0.043	0.035	0.006
Oil & Grease	17.9	<1.0	<1.0	<1.0
Gross Alpha*****				5.93
Gross Beta*****				13.95
Alkalinity	297.	226.	228.	229.
Chlorine Residual	0.05	<0.05	<0.05	0.10 0.3

* Standard Units

** Milliliter/liter

*** Organisms/100 ml

**** Micrograms/liter

***** Picocuries/liter (within normal background levels)

< Denotes equal to or less than

All results expressed as milligrams/liter, unless otherwise specified.

SOURCE: Environmental Consultants Laboratory, an independent testing laboratory.

TABLE A-5. SUMMARY OF MINIMUM REQUIREMENTS FOR INDIVIDUAL SEWAGE SYSTEM DISPOSAL SYSTEMS.

General. For lot sizes less than 2.5 acres, need approval of County Health Department prior to recording of plat.

Septic tanks. Minimum setbacks of tank and drainfield are 50 feet from well, 5 feet from dwellings. House sewer line must be 10 feet from well. Boxes and drainfields must be 10 feet from dwellings and 15 feet from water lines. All parts must be 5 feet from property lines. Tank may be steel or concrete, single compartment, with minimum capacity of 1000 gallons per month. Where the percolation rate is 30 minutes per inch or less, the minimum lot size is 0.5 acre if there is public water supply, 0.8 acre if there is individual water supply. 1 acre is required if the percolation rate is 31 to 60 min./in. Slope of the drainfield is not to exceed 6 inches per 100 feet. Drainfield must be sized on the basis of a minimum of three percolation tests performed by the Health Department or a registered engineer.

Sewage lagoons. Restricted to areas where percolation rate is over 60 min./in. Lot size must exceed 2.5 acres; setback requirements similar to septic tanks. Lagoon must be sized for total retention, with impervious dikes and bottom. In Norman, the City Council must approve each installation.

Source: Oklahoma State Deaprtment of Health, Bulletin No. 600, Oklahoma City, Oklahoma.

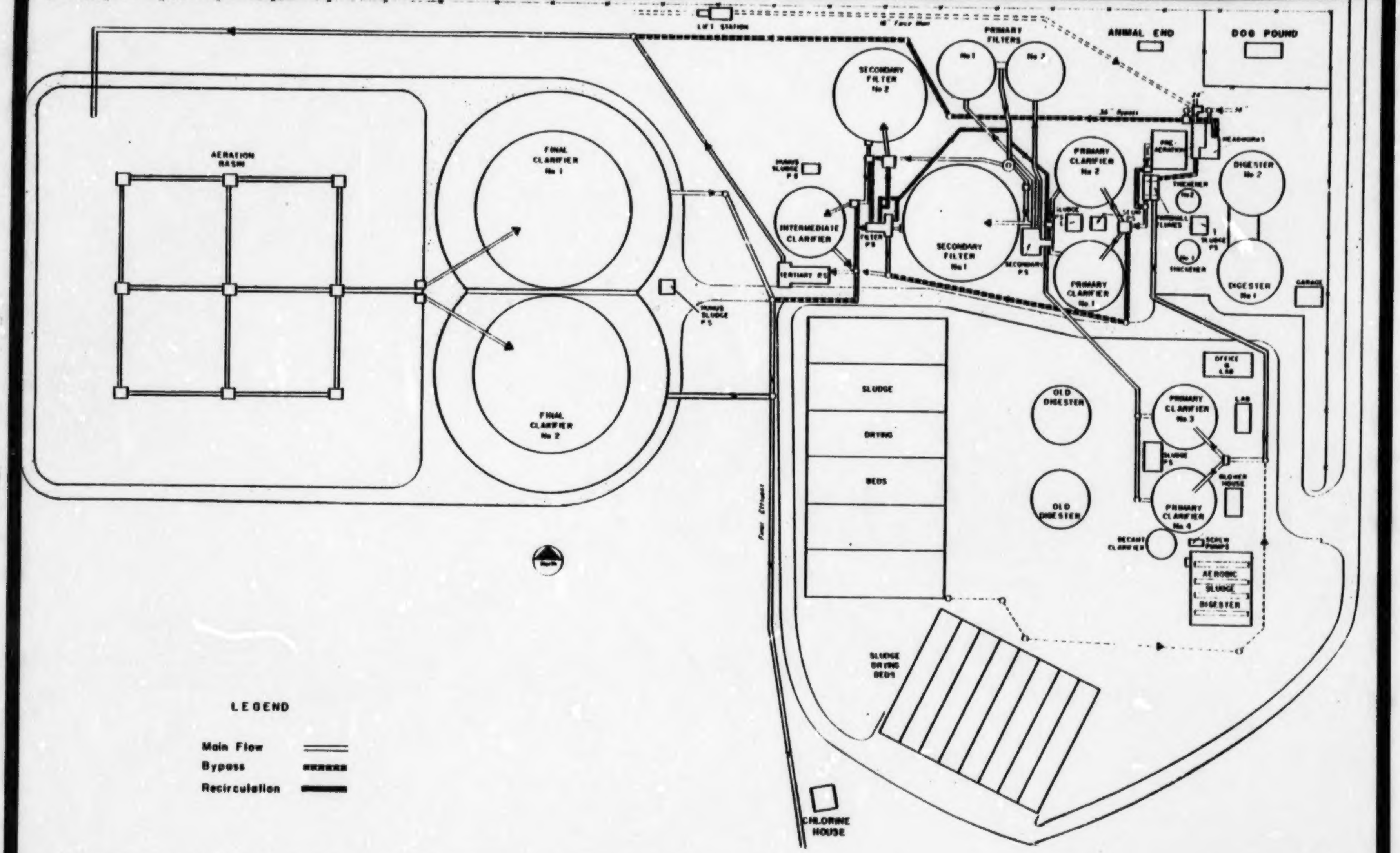

LIFT STATION
16" Force Main
PRIMARY FILTERS
No 1
No 2
ANIMAL END
DOG POUND
SECONDARY FILTER No 2
36" Bypass
24"
36"
HEADWORKS
PRE-AERATION
HUMUS SLUDGE PS
INTERMEDIATE CLARIFIER
FILTER PS
TERTIARY PS
SECONDARY FILTER No 1
SECONDARY PS
PRIMARY CLARIFIER No 2
PRIMARY CLARIFIER No 1
SLUDGE PS
SCUM PS
PARSHALL FLUMES
THICKENER No 2
THICKENER No 1
SLUDGE PS
DIGESTER No 2
DIGESTER No 1
GARAGE
AERATION BASIN
FINAL CLARIFIER No 1
FINAL CLARIFIER No 2
HUMUS SLUDGE PS
Final Effluent
SLUDGE
DRYING
BEDS
OFFICE & LAB
OLD DIGESTER
OLD DIGESTER
PRIMARY CLARIFIER No. 3
LAB
SLUDGE PS
BLOWER HOUSE
PRIMARY CLARIFIER No. 4
DECANT CLARIFIER
SCREW PUMPS
AEROBIC SLUDGE DIGESTER
SLUDGE DRYING BEDS
North
CHLORINE HOUSE
LEGEND
Main Flow
Bypass
Recirculation

FIGURE A-1. EXISTING WASTEWATER TREATMENT PLANT

APPENDIX B

INFORMATION RELATED TO SELECTION OF ALTERNATIVES

APPENDIX B. INFORMATION RELATED TO SELECTION OF ALTERNATIVES

Table of Contents Page

Introduction B- 2
Table B-1. Summary of financial information B- 4

INTRODUCTION

This appendix contains cost information on the facilities plan recommended alternative, plus a brief description of the proposed action. Refer to the facilities plan for more detail and for schematics of the proposed facilties.

The collection system would be expanded adjacent to already developed and serviced areas, primarily to the north and east of urban Norman. New interceptors would be built to relieve presently or soon to be overloaded lines and to accommodate the expanded service area.

The wastewater treatment plant would consist of a single 10.0 mgd plant at the existing site. For level A, the proposed alternative (number 4) would provide new rotating biological contactors (RBC or bio-discs) following the existing plastic-media filters which would serve a first-stage roughing filters. The existing final clarifiers would be modified into two new secondary clarifiers. The existing aerated lagoon would be used as a storm holding pond.

For level D, the level A system would be followed by biological nitrification units, a chemical coagulation system, and gravity sand filters. Only the filters would be needed for level B treatment; associated equipment includes a filter pump station and backwash storage.

For level C treatment, the biological nitrification units would be constructed. This would involve converting the existing final clarifiers to nitrification clarifiers surrounded by concentric nitrification aeration basins. Also built would be a nitrification sludge pump station and a nitrification sludge flotation unit. New RBC clarifiers and a sludge pump station would replace the existing clarifiers.

For level D treatment, the chemical coagulation system would be added onto level C. Specific units required would include solids contact units, a pH adjustment unit, a floc carryover basin, a chemical sludge pump station and a gravity thickener.

Incremental costs for each level of treatment are as follows.

Treatment level	Total cost	Total present worth
A	$ 6,781,000	$11,561,778
B	1,824,000	2,373,593
C	5,129,00	7,995,322
D	3,820,000	7,190,630
TOTAL for level D	$17,554,000	$29,121,323

The proposed action would retain the existing primary treatment units including headworks, aerated grit chamber, and primary clarifiers. The primary filters would be retained as roughing filters. The existing aerated lagoon would be retained for use as a storm holding pond. The final clarifiers would be modified and converted to secondary clarifiers of smaller size. The existing anaerobic digesters, gravity thickeners and sludge pump station would be retained for use with primary sludge. The existing aerobic digestor would be converted to a sludge holding tank. The existing sludge drying beds would be used as a dewatering backup.

The existing secondary filters, intermediate clarifier and filter pump station would be abandoned; refer to PSC (1981) for problems with these units.

Sludge would be dewatered on vacuum coil filters, mixed with municipal refuse, and incinerated. Heat from the incineration would be captured and used to generate electricity and steam. [Note that this is the facilities plan recommended sludge management system. It is likely, however, that the Appplicant will propose, instead, to anaerobically digest the sludge and dispose of it by wet-injection (land application).]

Cost and finance information for the facilities plan recommended alternative are presented in table B-1.

TABLE B-1. SUMMARY OF FINANCIAL INFORMATION.

Eligibility judgments below are those made by the facilities plan engineer. EPA has made no eligibility determinations at this time. Monthly charges could be more than presented below, depending on the eligibility of the work proposed. Costs for each level are cumulative.

	LEVEL A TREATMENT	LEVEL B TREATMENT	LEVEL C TREATMENT	LEVEL D TREATMENT	LINEWORK
CAPITAL COSTS:					
Total Cost	$ 6,781,000	$ 8,605,000	$13,734,000	$17,554,000	$ 9,605,827
Eligible Cost	$ 6,609,000	$ 8,387,000	$13,386,000	$17,070,000	$ 6,809,208
EPA Share	$ 4,956,750	$ 6,290,250	$10,039,500	$12,802,500	$ 5,106,906
City Share	$ 1,824,250	$ 2,314,750	$ 3,694,500	$ 4,751,500	$ 4,498,921
LOCAL FINANCING:					
Method - General Obligation Bonds @ 9 3/4%					
Bond Issue	$ 2,000,000	$ 2,500,000	$ 4,000,000	$ 5,200,000	$ 5,000,000
Annual Debt Service	$ 230,920	$ 288,650	$ 461,840	$ 600,390	$ 577,300
OPERATION AND MAINTENANCE COST:					
Annual Cost	$ 464,514	$ 517,914	$ 796,414	$ 1,123,914	$ 19,100
TOTAL MONTHLY CHARGES AND REVENUES:					
Estimated Monthly Charges for O & M	$ 1.21	$ 1.35	$ 2.07	$ 2.92	$ 0.05
Estimated Monthly Debt Service	$ 0.60	$ 0.76	$ 1.20	$ 1.56	$ 1.50
Estimated Total Monthly Charge	$ 1.81	$ 2.10	$ 3.27	$ 4.48	$ 1.55
Estimated Connection Charge	$ 50.00	$ 50.00	$ 50.00	$ 50.00	$ 50.00

Source: PSC, 1981.

APPENDIX C

COORDINATION

APPENDIX C. SUPPLEMENTAL COORDINATION

Table of Contents Page

Letter from U.S. Fish and Wildlife Service C- 2
Letter from Oklahoma Historical Society C- 3
Letter from Oklahoma Archeological Society C- 3
Letter from Oklahoma Historical Society C- 4
Letter from Oklahoma Archeological Society C- 4
Letter from U.S. Army Corps of Engineers C- 5
Flood plain construction notice C- 6

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE

POST OFFICE BOX 1306
ALBUQUERQUE, NEW MEXICO 87103

IN REPLY REFER TO:
SE

December 6, 1979

RECEIVED
DEC 10 1979
EPA
REGION VI
S & A DIV.
FED. ASST.

Mr. Clinton B. Spotts
Regional EIS Coordinator
U.S. Environmental Protection Agency
1201 Elm Street
Dallas, Texas 75270

Dear Mr. Spotts:

This is in reply to your November 9, 1979 letter which requested information about species which are listed or proposed to be listed as threatened or endangered as provided by the Endangered Species Act. Your areas of interest are wastewater treatment facilities at San Antonio, Texas, Crownpoint, New Mexico, and Norman, Oklahoma.

As provided by Section 7(c) of the Endangered Species Act Amendments of 1978, the Fish and Wildlife Service is required to furnish a list of those species, both proposed and listed, that may be affected by Federal construction activities.

Upon receipt of the Fish and Wildlife Service's species list, the Federal agency authorizing, funding, or carrying out the construction action is required to conduct a biological assessment for the purpose of identifying listed species which are likely to be affected by such action. Proposed species are included on the list even though they do not have legal protection under the Act. Their inclusion recognizes that they may be listed anytime and have the portent to cause delays or modifications to the proposed action. In light of this, we recommend that those species be included in the biological assessment.

The biological assessment shall be completed within 180 days after receipt of the species list, unless it is mutually agreed to extend this period. The biological assessment should include: 1) the results of a comprehensive survey; 2) results of any studies undertaken to determine the nature and extent of any impacts on identified species; 3) consideration of the cumulative effects upon the species or its critical habitat; 4) study methods used; 5) difficulties encountered in obtaining data and completing the proposed study; 6) conclusions including recommendations as to further studies, and 7) any other relevant information.

For purposes of providing interim guidance, the Fish and Wildlife Service considers construction projects to be any action conducted or contracted by the Federal agency designed primarily to result in the building or erection of man-made structures, such as dams, buildings, roads, pipelines, and the like. This includes consideration of major Federal actions such as permits, grants, licenses, or other forms of Federal authorization or approval which may result in construction and which significantly affect the quality of the human environment. In addition, other actions that have the potential of becoming or are controversial, may be considered as construction.

If the biological assessment reveals that the proposed project may affect listed species, the formal consultation process shall be initiated by writing to the Regional Director, Region 2, U.S. Fish and Wildlife Service, P.O. Box 1306, Albuquerque, New Mexico 87103. If no affect is evident, there is no need for further consultation. We would, however, appreciate the opportunity to review your biological assessment.

The attached sheet provides information on species which may occur in the proposed project area. If we may be of further assistance, do not hesitate to call upon us (505-766-3972; FTS 474-3972).

Sincerely yours,

Acting Regional Director

Attachment

cc: Austin Area Office (SE), Austin, Texas
Phoenix Area Office (SE), Phoenix, Arizona
ES Field Office, Tulsa, Oklahoma
ES Field Office, Ft. Worth, Texas
ES Field Office, Albuquerque, New Mexico

Norman, Cleveland County, Oklahoma

LISTED SPECIES

None.

PROPOSED SPECIES

None.

CRITICAL HABITAT

None.

OKLAHOMA HISTORICAL SOCIETY
Historical Building
Oklahoma City, Oklahoma 73105-4997

May 7, 1982

Ann Claassen
Associate
Lee Wilson & Associates
P.O. Box 931
Santa Fe, New Mexico 87501

Re: McClain County, Sewer-line construction, T8N, R3W Sec. 23-26, 35 and 36, T8N, R2W Sec. 29-33; and T7N R2W Sec. 4-6

Dear Ms. Claassen:

There are no sites on either the National Register of Historic Places or the Oklahoma Landmarks Inventory within the referenced project area. Pending compliance with recommendations of the Oklahoma Archeological Survey, the State Historic Preservation Office has no objections to completion of the referenced project.

Sincerely,

CEMetcalf
Earle Metcalf
State Historic Preservation Officer

CEM:kt

The University of Oklahoma
OKLAHOMA ARCHAEOLOGICAL SURVEY
1808 Newton Drive
Norman, Oklahoma 73019
(405) 325-7211

April 16, 1982

Ann Claassen, Associate
Lee Wilson & Associates
P.O. Box 931
Santa Fe, NM 87501

Re: Revised sewer plan for the city of Norman, Oklahoma.

Dear Ms. Claussen:

I have checked our files against the referenced projects areas of potential effect. None will affect recorded archaeological sites. There are several locations that we will need to survey for archaeological remains before they are more seriously disturbed. I do need from you the time frame from planning to implementation of the sludge application areas and the Chemical Sludge and Ash Disposal sites. Also, if there are any locations you are definately not going to use we would like to know that. Are all the square miles marked on the McClain County side to be used for sludge application, or are there some areas that will be selected from these? If so, are you at a point to identify them now?

Please let us know this information as soon as possible so that we can schedule them for survey.

Sincerely,

Larry Neal
Larry Neal
Staff Archaeologist

LN:ng

cc: Marshall Gettys, S.H.P.O.

OKLAHOMA HISTORICAL SOCIETY
Historical Building
Oklahoma City, Oklahoma 73105

August 12, 1981

Stevan Anderson
Lee Wilson and Associates
P.O. Box 931
Santa Fe, New Mexico 87501

Re: Environmental Impact Statement for wastewater treatment facilities proposed for Norman, Oklahoma.

Dear Mr. Anderson:

There are no sites on either the National Register of Historic Places or the Oklahoma Landmarks Inventory within the referenced project area. Pending compliance with recommendations of the Oklahoma Archeological Survey, the State Historic Preservation Office has no objections to completion of the referenced project.

Sincerely,

Melvena Thurman
for
Earle Metcalf
State Historic Preservation Officer

CEM:kt

The
University of Oklahoma at Norman
Oklahoma Archaeological Survey

August 13, 1981

Mr. Stevan Anderson
Lee Wilson & Associates
P.O. Box 931
Santa Fe, New Mexico 87501

Re: City of Norman Wastewater Treatment Facilities. Cleveland County, Oklahoma.

Dear Mr. Anderson:

I have evaluated the referenced project for its potential impact upon Oklahoma's archeological resources. The project does not take place on a known archeological site nor does it appear to be in a location likely to contain such a site. Consequently, I recommend that the project be allowed to proceed.

However, should any archeological remains be exposed during the course of construction, I request that my office be notified at once so that we may evaluate the possible site. Thank you for this opportunity to comment upon this project.

Sincerely,

Larry Neal
Staff Archaeologist II

WLN:rw

cc: State Historic Preservation Officer, Attn: Marshall Gettys
City of Norman
Environmental Protection Agency

1335 South Asp Avenue, Norman, Oklahoma 73019 (405) 325-1025

DEPARTMENT OF THE ARMY
TULSA DISTRICT, CORPS OF ENGINEERS
POST OFFICE BOX 61
TULSA, OKLAHOMA 74121

REPLY TO ATTENTION OF:
SWTOD-NR

28 January 1982

Mr. Stevan Anderson
Lee Wilson and Associates
PO Box 931
Santa Fe, NM 87501

Dear Mr. Anderson:

This is in reference to your 20 January 1982 letter concerning the proposed improvements to the Norman, Oklahoma, wastewater treatment plant.

Based upon information contained in your letter, the proposal will not involve the discharge of dredged or fill material below the ordinary high water mark of the South Canadian River; therefore, a Department of the Army Section 404 permit will not be required. The South Canadian River at this location is not a navigable water of the United States; therefore, work associated with this proposal will not require authorization under Section 10 of the River and Harbor Act of 1899.

If you have any questions concerning this matter, please contact Mr. Rick Gardner of our Regulatory Functions Section at (918) 581-7352.

Sincerely,

JAMES P. JONES
Chief, Operations Division

FLOOD PLAIN CONSTRUCTION NOTICE

The following notice is prepared in compliance with Executive Order 11988 (reference: Flood Management Guidelines, U.S. Water Resources Council, 43 CFR 6030, February 10, 1978)

The City of Norman proposes to construct several interceptors within 100-year floodplain areas of Norman. Possibly affected floodplains are Normandy (Merckle) Creek, Imhoff Creek, Bishop Creek, and an unnamed tributary of the Little River in Section 9 of range 2 west, township 9. The proposed action is described and evaluated in the Draft Environmental Impact Statement for the Norman Wastewater Facilities Plan, and is illustrated on the attached maps. The routes of the proposed sewers have not been surveyed and finalized, and the extent and location of possible floodplain construction is not definitely known. For Bishop Creek, it is anticipated that approximately 20% of the proposed construction would occur within the 100-year floodplain.

Advanced construction in the Bishop Creek floodplain has been approved by EPA and is currently underway. An Environmental Information Document was prepared for that action; the document included a flood plain construction notice.

The above actions are proposed to be located in floodplains because: a) such locations are necessary to achieve required gradients of the sewer lines; b) alternative locations would be more expensive; c) the construction can be undertaken in a manner which will avoid harm to or within the floodplains and will have no adverse effect on the floodplains; d) construction of sewers in the floodplains will conform to applicable federal, state and local floodplain protection standards; and e) there will be no structures constructed above the surface of the floodplains other than manholes, and the action involves no development of the floodplain.

The major alternatives to the proposed alignments are to use existing street rights-of-way in the area. While these alternatives would avoid construction in the flood hazard areas, they would require extensive excavation of streets, with attendent impacts of noise, traffic and business disruption and possible interruption of utilities. These alternatives would also result in a major increase in project costs due to the removal and replacement of street surfacing, and the greater excavation needed to obtain the necessary wastewater flow gradients.

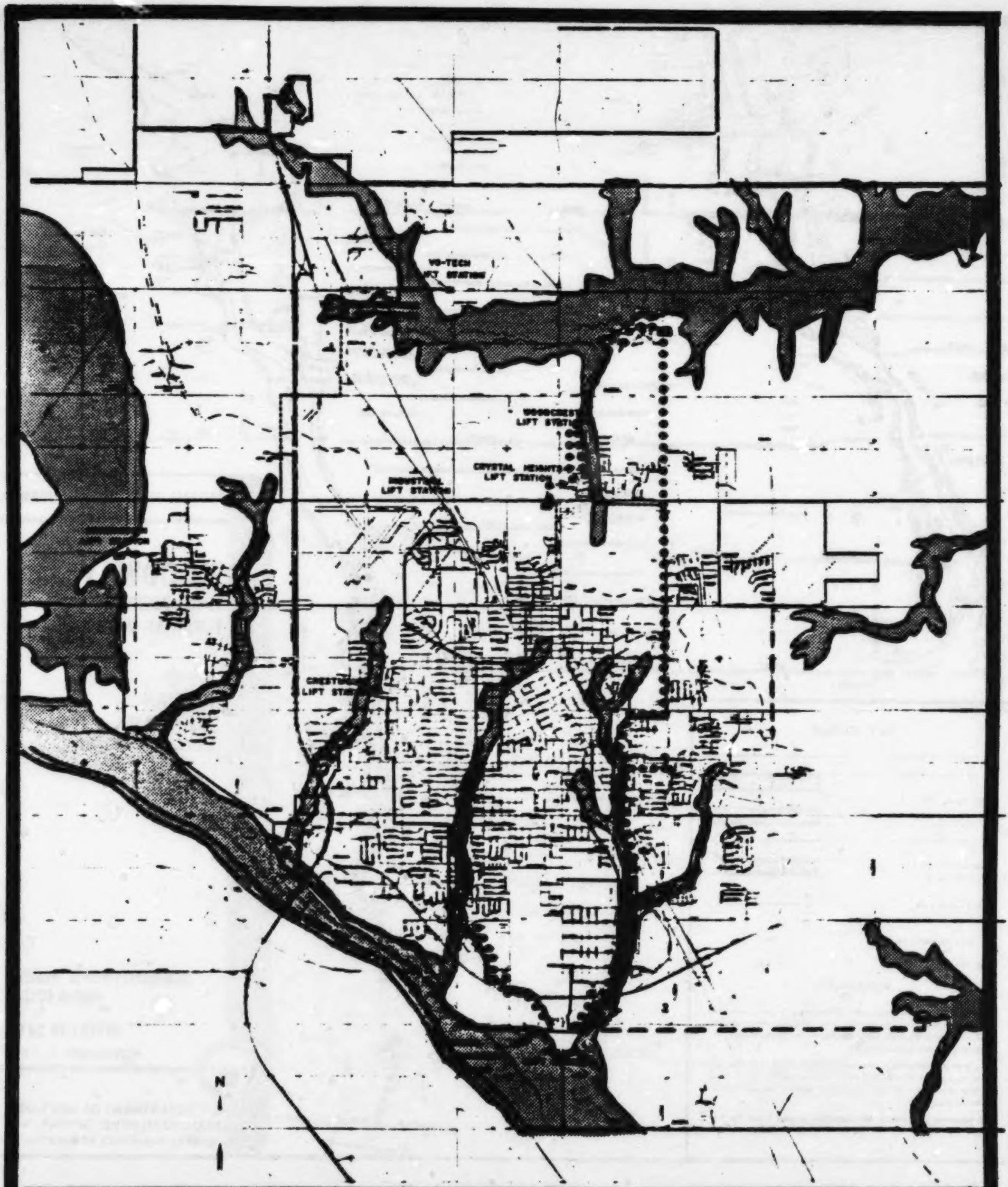
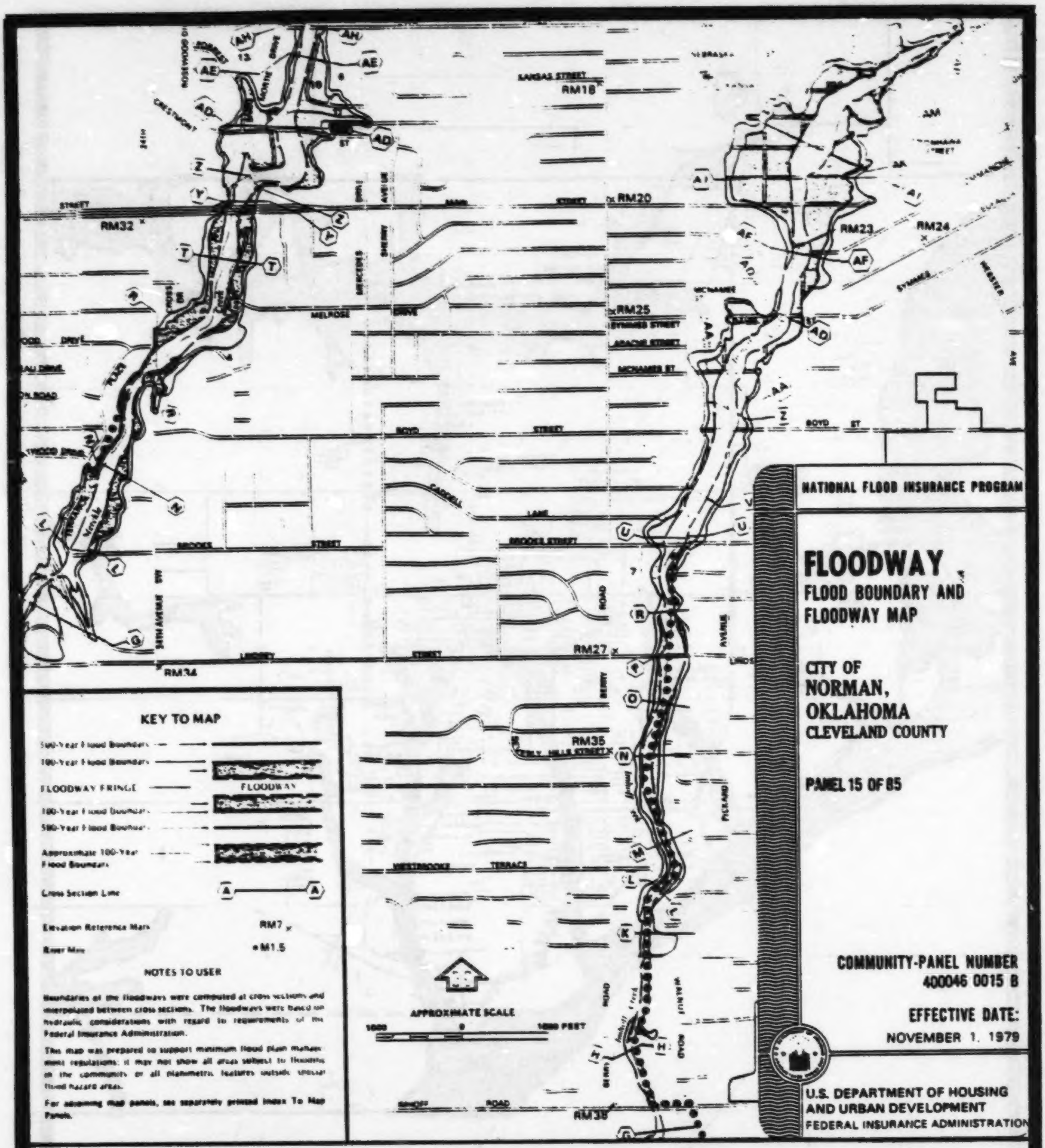

VO-TECH LIFT STATION
WOODCREST LIFT STATION
CRYSTAL HEIGHTS LIFT STATION
INDUSTRIAL LIFT STATION
CRESTVIEW LIFT STATION
N
100-year floodplain
Existing Interceptor
Existing Force Main
Lift Station
Initial line construction
Future line construction

FIGURE 6-2. FLOOD HAZARD AREAS

Source: HUD, 1979.


NATIONAL FLOOD INSURANCE PROGRAM
FLOODWAY
FLOOD BOUNDARY AND FLOODWAY MAP
CITY OF NORMAN, OKLAHOMA
CLEVELAND COUNTY
PANEL 15 OF 85
COMMUNITY-PANEL NUMBER 400046 0015 B
EFFECTIVE DATE: NOVEMBER 1, 1979
U.S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
FEDERAL INSURANCE ADMINISTRATION
KEY TO MAP
500-Year Flood Boundary
100-Year Flood Boundary
FLOODWAY FRINGE
FLOODWAY
100-Year Flood Boundary
500-Year Flood Boundary
Approximate 100-Year Flood Boundary
Cross Section Line
Elevation Reference Mark
RM7
River Mile
M1.5
APPROXIMATE SCALE
1000
0
1000 FEET
RM18
RM20
RM23
RM24
RM25
RM27
RM32
RM34
RM35
RM38
KANSAS STREET
MAIN STREET
MELROSE DRIVE
BOYD STREET
BROOKS STREET
LINDSEY STREET
CADDELL LANE
WESTBROOKE TERRACE
IMHOFF ROAD
BERRY ROAD
PICKARD AVENUE
SYMMES STREET
APACHE STREET
MCNAMEE ST
BEVERLY HILLS STREET
24TH AVENUE SW

NOTES TO USER

Boundaries of the floodways were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the Federal Insurance Administration.

This map was prepared to support minimum flood plain management regulations; it may not show all areas subject to flooding in the community or all planimetric features outside special flood hazard areas.

For adjoining map panels, see separately printed Index To Map Panels.

▬ Lift Station

●●●●●●●● initial line construction

FIGURE 6-3. ROUTE OF PROPOSED BASIN A & B INTERCEPTORS

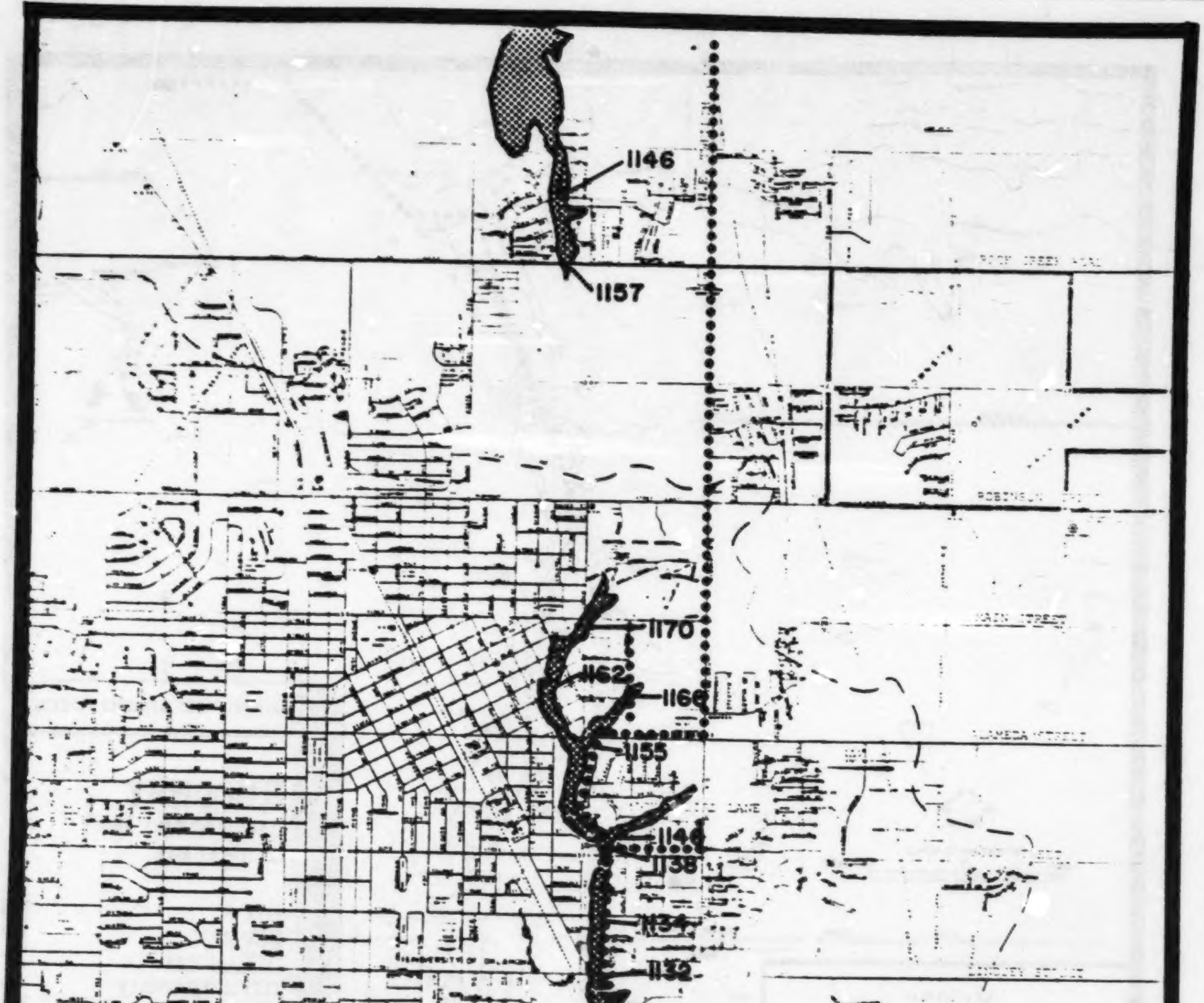
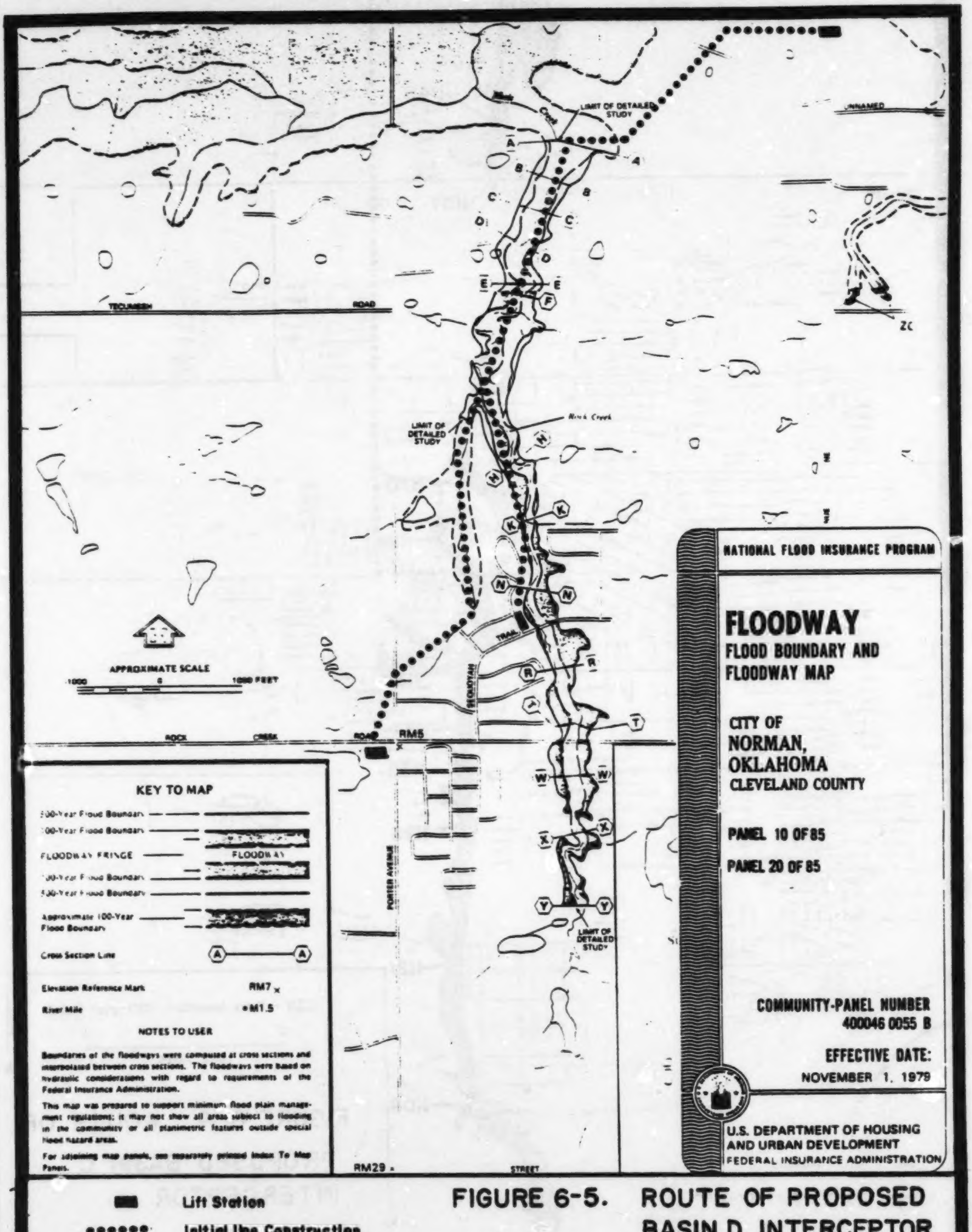

1146
1157
ROCK CREEK ROAD
ROBINSON STREET
MAIN STREET
1170
1162
1166
ALAMEDA STREET
1155
1146
1138
1134
UNIVERSITY OF OKLAHOMA
LINDSEY STREET
1132
1126
1121
1109
1138 — Base elevation, 100-year flood
0
1
one mile
N
Lift Station
Initial line construction

FIGURE 6-4. ROUTE OF PROPOSED BASIN C INTERCEPTOR

Source: HUD, 1974


LIMIT OF DETAILED STUDY
UNNAMED
TECUMSEH ROAD
Rock Creek
LIMIT OF DETAILED STUDY
TRAIL
SEQUOYAH
APPROXIMATE SCALE
1000 0 1000 FEET
ROCK CREEK ROAD
RM5
PORTER AVENUE
LIMIT OF DETAILED STUDY
RM29
STREET
A
B
C
D
E
F
H
K
N
R
T
W
X
Y
KEY TO MAP
500-Year Flood Boundary
100-Year Flood Boundary
FLOODWAY FRINGE
FLOODWAY
100-Year Flood Boundary
500-Year Flood Boundary
Approximate 100-Year Flood Boundary
Cross Section Line
Elevation Reference Mark RM7
River Mile M1.5
NATIONAL FLOOD INSURANCE PROGRAM
FLOODWAY
FLOOD BOUNDARY AND FLOODWAY MAP
CITY OF NORMAN, OKLAHOMA CLEVELAND COUNTY
PANEL 10 OF 85
PANEL 20 OF 85
COMMUNITY-PANEL NUMBER 400046 0055 B
EFFECTIVE DATE: NOVEMBER 1, 1979
U.S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
FEDERAL INSURANCE ADMINISTRATION
Lift Station
Initial line Construction

NOTES TO USER

Boundaries of the floodways were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the Federal Insurance Administration.

This map was prepared to support minimum flood plain management regulations; it may not show all areas subject to flooding in the community or all planimetric features outside special flood hazard areas.

For adjoining map panels, see separately printed Index To Map Panels.

FIGURE 6-5. ROUTE OF PROPOSED BASIN D INTERCEPTOR

INDEX

INDEX

Acronyms . . . 10-1
Administrative Order . . . 4-7
Advance construction . . . 4-1, 4-5ff
Aerated lagoon . . . 1-1; 4-3; 5-26
Air quality . . . 3-8; 5-42; 6-39ff, 62
Algae/algal blooms . . . 1-3; 5-7; 6-19, 50, 52
Alternatives
  No-action alternative . . . 1-1; 5-1; 6-1, 6, 29, 43, 51, 55, 72, 79
  Service area alternatives . . . 1-2, 5-8
  Collection system alternatives . . . 1-4; 5-9; 6-7, 29, 43, 51, 55, 72, 79
  Treatment alternatives . . . 1-3; 5-24; 6-7, 35, 44, 52, 55, 72, 80
  Plant location alternatives . . . 5-32
  Sludge management alternatives . . . 1-4; 5-32ff; 6-7, 37, 45, 53, 56, 72, 80
  Administrative alternatives . . . 5-48
  Funding alternatives . . . 1-8; 5-48ff
  Other alternatives . . . 1-7; 5-43; 6-8, 38, 47, 54, 56, 76, 83
  Preferred alternative . . . 1-8; 5-49
  EPA alternatives . . . 1-8; 5-51, 6-1, 8, 38, 47, 54, 56, 78, 84
  Other agency alternatives and involvement . . . 3-6
  Wastewater reuse alternatives . . . 1-4; 5-31
Agricultural lands . . . 1-2; 3-7; 5-3, 6, 15, 18, 68ff
Aquatic habitat . . . 6-48, 53
Archaeologic resources . . . 3-7; 6-54ff
Association of Central Oklahoma Governments (ACOG) 3-6; 4-10; 6-15, 19, 63, 68
  ACOG model . . . 6-20, 31, 35, 53
Bio-discs . . . 1-4; 5-26, 30; 6-44; B-2
Biology . . . 6-5; 6-47ff
Blooms (see Algal blooms)
Central State Hospital . . . 3-1; 5-17; 6-57
Citizens Advisory Committee . . . 3-6; 5-19, 50; 6-75; 7-1ff
Clean Water Act . . . 3-4; 5-10
Climate . . . 6-2
Chlorination . . . 1-7; 5-27, 30, 44; 6-38, 79
Chlorophyll *a* . . . 6-27, 33, 50
COMPLAN . . . 1-1, 2; 4-3, 4, 5; 5-2ff, 8, 10, 15, 19, 21; 6-59ff, 71, 73ff
Collection lines . . . 4-1; 5-10ff
  sizing . . . 5-20
Construction impacts . . . 1-4; 5-22; 6-29, 51, 73
Cost-effectiveness analysis . . . 1-8; 4-12; 5-24; 6-1
Costs
  collection system . . . 5-14
  facilities plan proposed alternative . . . 5-50; B-2, 4
  wastewater treatment facilities . . . 1-4; 5-30
  sludge management . . . 1-4; 5-37
Court Order . . . 4-6; 5-18
Crystal Heights lift station . . . 5-18f

Dewatering
  ground water . . . 5-22; 6-30
  sludge . . . 5-34
Disinfection . . . 1-1, 7; 5-34, 42, 44; 6-38, 79
Drainage ordinance . . . 1-3; 5-47
Economic conditions . . . 6-57
Ecotone . . . 6-47
Effluent limitations . . . 1-1; 4-7, 10; 5-26
Employment . . . 6-57
Endangered and threatened species . . . 3-8; 6-50f
Energy use, conservation, and recovery . . . 1-7; 3-4; 5-33, 40, 45; 6-62, 78ff
Environmental Information Document . . . 4-7; 5-18; 7-2, 5
Erosion . . . 5-12, 13, 22; 6-7, 27, 29, 34, 43
Eutrophication . . . 4-12; 6-19
Existing facilities and problems . . . 4-3; A-2ff
Facilities plan . . . 3-1; 4-4, 5; 5-6, 26, 51
Fees, sewer . . . 5-48
Fertilizer . . . 5-46; 6-27, 71
  Sludge . . . 5-3, 33, 36, 40; 6-7f
Fish . . . 3-7; 4-10; 5-44; 5-35; 6-48, 50, 52, 53
Floodplains, flood hazards 3-7; 4-4; 5-12, 13, 21, 32, 33; 6-10, 29, 34f, 37 38
Flow reduction (see water conservation)
Funding . . . 1-7; 3-1, 4, 5; 4-4, 7; 5-10, 13, 34, 48ff; 6-78; B-4
Geology . . . 6-2ff
Goldsby . . . 5-32; 6-76
Ground water . . . 5-33, 40, 44; 6-15, 27f, 29, 37, 39
Growth impacts . . . 6-52, 73
Health impacts . . . 1-1; 3-5; 4-6; 5-12, 33, 42, 44; 6-59, 74, 76
Historic resources . . . 3-7; 6-54ff
Hookup moratorium . . . 1-2, 2; 4-5, 7; 5-2, 18; 6-63, 74
Industrial flows . . . 5-48
Infiltration/inflow . . . 5-10
Infrastructure . . . 6-73
Innovative technology . . . 3-4; 5-34
Interceptors (see Alternatives--Collection system) . . . 5-12
Lake Eufala . . . 4-12; 6-19
Lake Stanley Draper . . . 6-9
Land application
  sludge . . . 5-34, 35ff, 37; 6-45, 53, 76
  wastewater . . . 1-4; 5-26f, 30ff; 6-44, 76
Land use . . . 6-5, 30ff; 6-56ff
Lift stations . . . 5-21; 6-10, 79
Little River State Park . . . 3-1; 6-57
Methane . . . 5-36; 5-40ff, 45
Metric units . . . 10-11
Mitigation . . . 5-24, 25, 51; 6-34, 51, 53
Moore . . . 1-3; 5-7; 6-32, 33, 41, 68
Moratorium (see Hookup moratorium)
National Environmental Policy Act (NEPA) . . . 3-4, 5f
Natural regions . . . 6-2ff

Neighborhood community unit 6-62
Noise 3-8; 5-10, 12, 13, 22; 6-41f, 62
Nonpoint-source pollution 1-1; 4-1, 2ff; 5-46ff; 6-16, 20, 38
NPDES permit 1-1, 8; 3-4ff; 4-7; 5-2, 26, 50f; 6-39
Odors 1-1, 7; 4-1, 4-6; 5-1, 2, 17, 33f, 41, 45; 6-41ff, 59, 76
Oklahoma Department of Pollution Control (ODPC) 3-6
Oklahoma State Department of Health (OSDH) 3-6; 4-4, 10; 5-42, 43; 6-63
Oklahoma Water Resources Board (OWRB) 3-6; 4-7; 6-35
Oliver Wildlife Preserve 1-4; 6-44, 48, 51, 57
On-site systems 1-7; 5-2, 10, 43, 46; 6-6, 29, 38, 72; A-5
Organic loading 1-1; 4-3; 6-29
Overflows 1-1; 4-5f; 5-1, 12, 17; 6-41, 59
Phased growth 6-59
Phosphorus 1-2; 5-7, 15, 18, 20, 46; 6-6, 24, 30ff, 52
Piggy-backing 4-12
Planning area 3-1
Pollutants
  Air 5-42; 6-39ff, 45
  Water 1-2; 4-4; 5-6, 9, 47; 6-20ff, 30, 39, 51
Ponds 1-3; 5-7, 47; 6-9, 34; 50
Population 1-1; 3-1; 4-1, 2; 5-3; 6-32, 57, 63
Public participation 1-8; 3-6; 5-32, 42, 49; 7-1ff
Rankings/ratings
  sludge management 1-4, 6; 5-35ff
  wastewater treatment facilities 1-4, 5; 5-27ff
Reuse (see wastewater reuse)
Runoff 1-1, 2; 3-1; 5-6, 9, 46f; 6-19; 6-20ff, 31ff, 39, 73
Rural areas 1-2; 6-32
Septic tanks (see also On-site systems) 1-2; 6-29
Service area 1-2; 4-2; 5-5
Sludge management (see Alternatives--Sludge management)
Sludge digesters 1-1; 5-33f; 6-46
Socio-economic conditions 6-74
Soils 6-4, 6, 34
Stormwater runoff (see runoff)
Sutton Wilderness Park 5-17; 6-41, 43f, 57
Terrestrial habitat 6-52
Tradeoff analysis (see rankings/ratings)
Turbidity 6-16, 27, 34, 52
University of Oklahoma 6-48, 51, 57
Vegetation 6-47ff, 53
Wasteload allocations 3-6; 4-7, 11; 6-19, 35, 53
Wastewater reuse 1-4; 5-31
Water conservation 5-46; 6-38, 84
Water quality . 1-1ff; 3-4ff; 4-4ff, 8; 5-7; 6-15ff, 30, 35, 39, 53, 73; A-2, 3
Water supply 1-1; 3-1; 4-4; 6-9, 29, 73
Wildlife 3-7; 5-6; 6-47ff, 53, 71
Woodcrest lift station/emergency detention pond 1-1; 4-1, 5; 5-18; 6-73